



THE OPEN UNIVERSITY OF SRI LANKA

**EXTENDED ABSTRACTS
ANNUAL ACADEMIC SESSIONS
27 - 28 NOVEMBER, 2013**

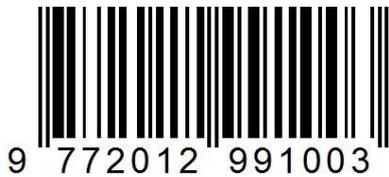
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MESSAGE FROM THE VICE-CHANCELLOR

I am very pleased to send this message to the proceedings of the Annual Academic Sessions of the Open University of Sri Lanka to be held on the 27th and 28th of November 2013.

We at the Open University have always believed that a strong research culture is an integral aspect of university and academic life and the Annual Academic Sessions were established as a way of encouraging and fostering this culture. The Open University in particular encourages independent and critical research since in our view universities should be a source of information and expertise to society at large. We hope that the work that is presented and discussed at these Sessions will further the various disciplines that they represent, as well as the interests of the public. As the premier distance education university in the country, the Open University Academic Sessions are also an opportunity to disseminate research on distance teaching and learning.

At the Open University we also believe that academic freedom is a core value to be promoted within academic institutions. It is this that ensures that universities become sites of innovation, creativity and critical thinking. When I look at the papers that are to be presented at these Sessions, I am pleased to note that Sri Lankan academics are continuing to engage in innovative and important areas of work. It is also noteworthy that the Sessions have attracted a large number of papers from outside the Open University. These academic exchanges help to strengthen the academic community in Sri Lanka and to encourage collaboration.

I congratulate the organizers for a job well done and appreciate all the hard work that went in to organizing this event. I am confident that the Open University Annual Academic Sessions for 2013 will continue the high standards the university has set itself in the past.

Dr. Vijitha Nanayakkara

Vice-Chancellor

PREFACE

On behalf of the Senate Sub-Committee, Annual Academic Sessions 2013, I am very pleased to present the published Proceedings of the Sessions. These Sessions will take place in the Faculty of Humanities and Social Sciences of the Open University of Sri Lanka on 27th and 28th November 2013.

This year we received 154 abstracts for review, of which 111 were accepted for presentation. Approximately one third were from researchers outside the Open University and in addition, a significant number of abstracts reflected collaborative research among academics from both within and outside the Open University. We are very pleased at the interest shown in our Academic Sessions, particularly by our colleagues from other universities in Sri Lanka, and look forward to such collaboration and inter-action continuing in the future.

The large number of abstracts accepted for the conference has enabled us to schedule three concurrent sessions during the two days, classified on the basis of the four faculties of the Open University – Education and Social Sciences, Engineering, and Natural Science. A plenary session on Open and Distance Learning on the first day reflects the importance of this unique mode of teaching in the Open University. The abstracts published in these Proceedings have been classified in more detail into 21 discipline based areas.

The abstracts, which comprised both applied and basic research, were subjected to a rigorous, blind review process by two independent reviewers, one from within the Open University and one from outside. The reviewers gave generously of their time, in many instances providing constructive feedback to enable the authors to further improve and enhance their abstracts. The high caliber of the review process thus ensured that the abstracts presented at these sessions have in turn reached a very high standard of academia. On behalf of the Senate Sub-Committee I sincerely thank all the reviewers who, in spite of their own busy schedules, helped to ensure the success of these Sessions and provided encouragement to researchers and authors in their work.

Firstly, I thank the Vice Chancellor for his support of the Annual Academic Sessions. I must acknowledge the contribution of the members of the Senate Sub-Committee who gave me their unstinted support throughout the organization of these Sessions, within a very short time frame. The four Faculty Representatives on the Committee, while undertaking the task of coordinating the review process also contributed immensely to other aspects of these Sessions. I appreciate the support of Mr. S H Uwaisulkarni, Deputy Registrar/Academic Administration who, while maintaining his heavy workload in the university, provided administrative and logistical support and convened and coordinated the meetings of the Sub-Committee. A very special word of thanks goes to Mr. Priyantha Nawarathne, Project Assistant, who willingly undertook a far greater share of the work than he was required to. His artistic talents have been demonstrated in the webpage and the conference stationary which he designed. He also maintained communication with authors and reviewers and undertook the final formatting of the abstracts. These sessions could not have been organized within a short time without his support and hard work.

The staff of the Department of Language Studies, as usual took on the arduous task of proof reading and language editing the abstracts. I would like to thank Dr. Dinali Devendra, Dr.

Vivimarie Medawattegedara, Dr. Radika De Silva, Dr. Kanchana Warnapala, Mr. Lal Medawattegedara, Ms. J.C.N Pullenayagam and Mrs. P Abeysooriya for all their hard work in preparing these proceedings for publication.

I must also thank the staff of the Deputy Registrar's office, Ms. Anoma Rajapakse and Ms. W L K D P Ratnakara for providing assistance during the proceedings, particularly with registration, and Mr. M N I Perera and Mr. K T S Prasad de Silva for office assistance.

A very special word of thanks goes to Mr. Mohan Karunaratne, Partner of V.V. Karunaratne and Company, one of our alumni who contributed generously to sponsoring this event, specially the fellowship dinner. I thank him and Dr. Ruminda Wimalasiri for making this event a reality.

Finally I would like to thank the Printer, Open University, Mr. Balachandra and the staff of the Open University Press for the good job done in printing the stationery and the Proceedings, all of which were submitted to them at the last possible moment.

We hope that these Annual Academic Sessions of the Open University will help to foster a culture of research and writing among all of us and will also be an opportunity for forging friendships and encouraging future collaboration and interaction among all the participants.

Professor Camena Guneratne

Chairperson/Senate Sub-Committee, Annual Academic Sessions 2013

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DETERMINATION OF CROP CO-EFFICIENT AND CROP WATER REQUIREMENT OF MUNGBEAN (*VIGNA RADITA* L.) IN DL1B AGRO ECOLOGICAL REGION OF SRI LANKA

K K P Dinushani, CS De Silva, M D M Gunawardhana

INTRODUCTION

Mungbean (*Vigna radita* L.) is becoming a very important pulse crop in the dry zone of Sri Lanka as it is used as a third season cultivation crop. Third season means Mungbean was cultivated after the paddy harvest using residual moisture in the paddy land with additional irrigation water. At present, farmers are opting for the production of this crop under irrigation due to changing pattern and uneven distribution of rainfall. However, the water requirement data and crop co-efficient of Mungbean crop is not locally available.

Crop co-efficient (Kc) values are required for estimating crop evapotranspiration (Hossain and Islam, 2010). There was no specific co-efficient value for Mungbean so far in Sri Lanka. Even in literature such as Food and Agriculture Organization publications, crop coefficient values of green gram of 110 days duration have been used so far. But this particular research intends to introduce a new specific and accurate value for Mungbean crop in Sri Lanka which takes only 65 days to mature. Crop coefficient which is the ratio of crop evapotranspiration (ET_c) with reference to evapotranspiration, is an important parameter in irrigation planning and management (Allen *et al.*, 1998). As the actual crop water requirement for local crops such as Mungbean is not known, the wastage of irrigation water is high. Physiological characteristics of crop varieties differ under different soil and climatic conditions, thus, showing varying physiological demands including crop water requirements. Hence, knowledge of experimentally determined Kc value is important for proper irrigation scheduling and efficient water management of the selected crop. In order to fulfill this, the study was designed for the determination of Mungbean ET and its crop coefficient (Kc). The results obtained will be useful for planning the supplemental or lifesaving irrigation. The objective of this research was to determine the crop coefficient for the different stages of the productive cycle of a Mungbean MI-6 variety, by using mini-lysimeter study results and weather data.

METHODOLOGY

Field experiments were conducted at the field of Grain Legumes and Oil Crops Research and Development Center (GLORDC), Angunukolapellessa during the period from November, 2012 to May, 2013. This research field is situated in the Southern dry zone of Sri Lanka. The research station belongs to the low country dry agro ecological region with reddish brown soil. Four sets of mini-lysimeters were assembled and used for this study to measure water balance parameters. Each set of mini-lysimeter consisted of a metal tank that had 0.3 meter square area and were 45 cm deep which served as the lysimeter tank and as non-weighing system where the crop was planted, with the drainage systems. Lysimeters were placed on the cement blocks and plastic bowls and buckets were kept under the lysimeter to collect the drainage. A polythene apron was used around the lysimeter to prevent rainwater splash as well as the overflow of water. The four lysimeters were irrigated with applied water or by natural rainfall. The drainage system consisted of a plastic bowl of 26 cm diameter and 18 cm deep which collects the drained water from the bottom of the lysimeter tank. The lysimeter tank was perforated at the bottom to allow drainage of water beyond what the soil can hold. Mungbean (variety: MI-6) was sown in four lysimeter tanks. Also, to maintain a similar environment, the same crop was grown in the lands surrounding the tanks. Mungbean plant spacing was 30 × 15 cm based on Department of Agriculture recommendation. Fertilization was conducted and basal dressing was applied at the rate of 12 kgN/acre, 40kgP/acre and 30kgK/acre. As a top dressings 14kg/ac was applied to the Mungbean

just after flowing. Chemical applications were conducted to control pest and diseases. (Imidacloprid 20 S. L for control white flies, Thiophanate and Invelveuron to control fungus and Thiamethoxam used for pests.)

The water balance data was collected and calculated daily in the growing period by applying the mass continuity equation and the evaporation was obtained by the difference between the soil water inputs and outputs (Equation 1).

$$ET_c = P - D - ES \pm \Delta A \dots\dots\dots (1)$$

Where ET_c is the crop evapotranspiration (mm), P the rainfall (mm), D the drainage (mm), ES the superficial runoff, and ΔA the soil water storage variation (mm).

Weather data for daily maximum and minimum temperatures, relative humidity, sunshine hours and wind speed were obtained from the Agricultural Meteorological Station Angunukolapellesa and Meteorological Department, Colombo and used to compute daily reference evapotranspiration (ET_0) using the FAO-Penman Monteith model (Allen *et al.*, 1998). The crop co-efficient was calculated using the following equation: (Burt *et al.*, 2005)

$$ET_c = K_C ET_0 \dots\dots\dots (2)$$

Where K_C is the crop coefficient and ET_0 is the reference evapotranspiration and ET_c is crop evapotranspiration.

RESULTS AND DISCUSSION

Reference evapotranspiration (ET_0)

Many methods are available for estimating reference evapotranspiration (ET_0). Reference evapotranspiration (ET_0) was calculated on the basis of Penman (1948) for a given environment using local weather parameters (From November 26 – January 30). The software developed by FAO based on Penman Monteith namely CROPWAT model was used to estimate ET_0 . Daily ET_0 was estimated using this setup .

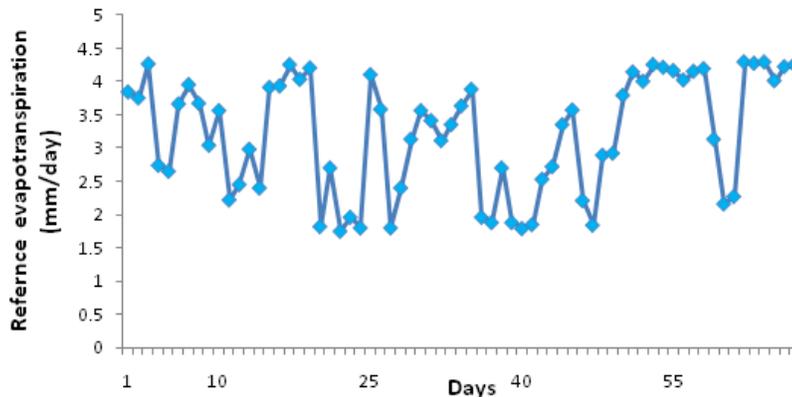


Figure 1 : Daily Reference evapotranspiration (ET_0) of the Mungbean Crop (November 2012- January 2013)

Trends of reference evapotranspiration (observed within growing period) are presented in Figure 1. The difference in ET_0 is attributed to combined effects of temperature, sunshine hours, radiation, wind speed and relative humidity. The increased in ET_0 during the end of growing season can be explained by the change in weather because lowest rainfall and longest sunshine days were observed during this period.

Daily Crop Evapotranspiration (Daily Crop Water Use)

Figure 2 show the trend of the daily crop evapotranspiration of the Mungbean crop during the growing season. There was no definite pattern for the daily crop evapotranspiration of Mung bean with respect to crop age as the values kept rising and falling throughout the crop growing season. This is typical of daily evaporation during the rainy season as higher evaporation does happen on very sunny and cloudless days and lower evaporation on cloudy and rainy days.

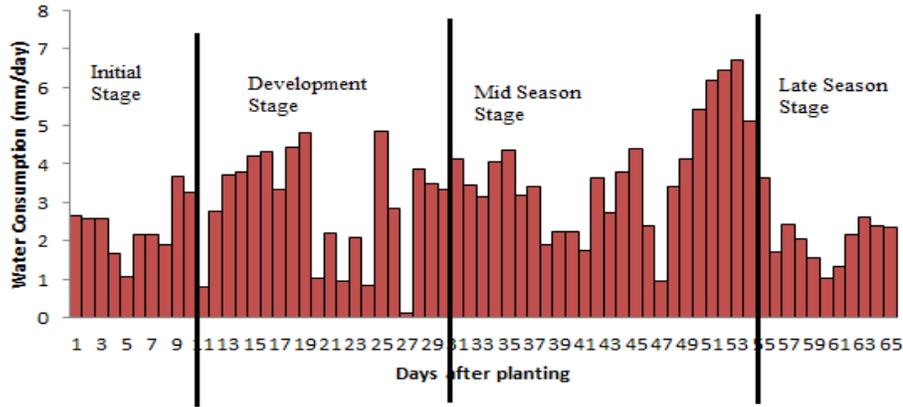


Figure 2 :Daily Crop Evapotranspiration of the Mungbean (November 2012- January 2013)

Crop co-efficient of the Mungbean

Values of the Mungbean crop coefficient, obtained in this study are presented in Figure 3. This figure shows that the Mungbean crop coefficient is not constant throughout its productive cycle.

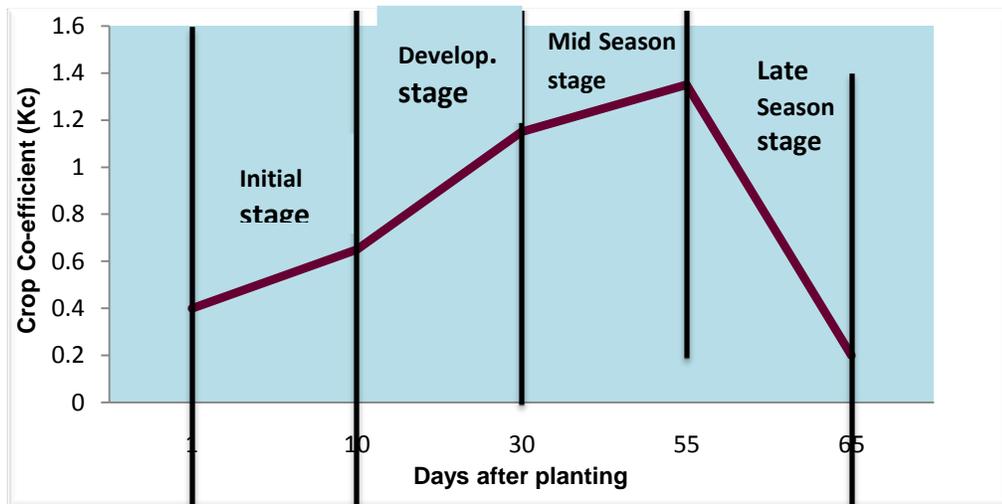


Figure 3: Crop coefficient (k_c) observed for Mungbean (November 2012- January 2013)

Table 1: Stage wise crop water requirement and co-efficient of Mungbean initial, development, Mid-season and late season growth periods

Stage	Length of growth Stages	Consumptive water requirement (mm)	Co-efficient value
Initial	8	16.77	0.58
Crop development stage	22	64.74	1.0
Mid-season stage	25	92.73	1.2
Late season stage	10	19.61	0.7

Water requirement were high for development and mid-season stage (64.74 and 92.73) and also crop coefficients were high for development and mid-season stage (1 and 1.2) respectively, because this was the period when the crop completed vegetative phase and flowering

CONCLUSIONS

The Mungbean evapotranspiration obtained by the soil water balance method, increased from 16.77 mm in the months of November and December at initial stage to 64.74 mm in December month at the development stage then it increased to 92.73 mm in December and January months at the mid- season stage after it declined to reach the values of evapotranspiration 19.61 mm in January month at the late-season.

Total water requirements of Mungbean for whole growing period were 193.8 mm.

The crop co-efficient values of MI-6 Mungbean at initial, development, mid-season and late season stages were found to be 0.5, 1, 1.2 and 0.7, respectively from the lysimeter study. These values differed from the standard values to some extent (Doorenbos and Pruitt, 1977), Therefore the calculated crop water use and crop coefficients will help to reduce the irrigation water as at present more than 4 times of water is used for MI-6 Mungbean crop. These results were taken from one season data therefore the study will be continued to confirm the results.

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WATER QUALITY ASSESSMENT IN JAFFNA, VAVUNIYA, ANURADHAPURA, KURUNAGALA AND HAMBANTOTA IN SRI LANKA FOR DOMESTIC PURPOSES

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INTRODUCTION

Groundwater quality deterioration is one of the major concerns of Sri Lanka as the majority of the people in the dry zone depend on groundwater for their drinking and domestic purposes as they do not have access to clean and safe water. Major aquifer type underlain in Sri Lanka except for northern and northwestern coastal areas is hard rock aquifer with very low transmissibility. Therefore, a large number of shallow wells or agro wells having large storage capacities are constructed to provide water for irrigation. However, people in these areas use these wells water for drinking and domestic purposes too as they do not have alternative sources. Since there are complaints about health issues such as Chronic Kidney Disease of unknown etiology (CKDu) and other water related diseases for which the quality of the water the community consumes may be responsible, a series of studies have been conducted in intensive agricultural production areas namely Jaffna, Vavuniya, Anuradhapura, Kurunagala and Hambantota representing a longitudinal section of Sri Lanka to understand the groundwater quality over the years of 2004 to 2009 (Figure 01).

METHODOLOGY

Analysis of chemical parameters of shallow groundwater in Jaffna Peninsula in forty drinking water wells at monthly interval was carried out from 2007 to 2009. Water quality assessments were also done on randomly selected 30 wells in the Thandikulam and Kurumankadu in Vavuniya and Thirappane in Anuradhapura during 2006 to 2007 at monthly intervals.. Malsiripura in Kurunagala also engaged in intensive agricultural activity and 10 randomly selected wells were taken for this study during 2004 to 2005 at monthly intervals. The study in the Hambantota district was carried in 2006 at monthly intervals, to assess water quality and sanitation for wells used for domestic purposes after the complaint made by the Medical Office of Health (MOH) of the area for Calculi in the urinary tract leading to renal failure and diarrhoeal diseases. Accordingly water quality assessments were done in Hambantota on randomly selected 15 wells in GN divisions of Bataatha North, Kivula South and Welipatanvila. pH, turbidity, conductivity, and fecal coli form were analyzed using the water quality microbial analysis kits (Dealgua) while nitrate-N, nitrite-N, ammonium-N, chloride, fluoride, calcium, magnesium, sulphate, iron, arsenic and phosphate were analyzed using the UV/Visible Spectrophotometer.

RESULTS AND DISCUSSION

According to the results in the Jaffna peninsula, the total iron, phosphate, manganese, arsenic, pH did not reach harmful levels even though the aquifer is highly porous and heavy fertilizer use for intensive agricultural activities was adopted. Salinity developments, high level of nitrate -N, low level of fluoride were identified as major health hazards in the study area (Figure 02). Figure 02 shows that some public, domestic and farm well exceed the permissible limit of 10mg/l of Nitrate Nitrogen. The health hazards of consumption of high nitrate contaminated drinking water was studied and emphasized by a number of scientists. Nitrate is associated with diseases like methaemoglobinemia, gastric cancer, thinning of blood vessels, aggressive behavior and hypertension (Kuruppuararachi, 1995). Sivarajah (2003) supported this and reported that high nitrate content in water could be related to the high prevalence of cancer of the gastrointestinal tract in the people of Jaffna.

It could be converted into carcinogenic substances such as nitrosoamines within the body and is of importance in the incidence of esophageal cancer in the Jaffna district.

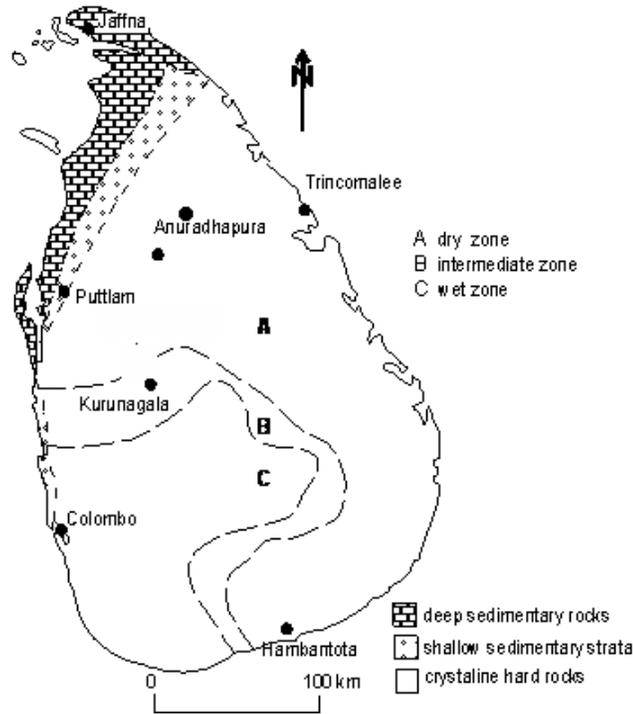


Figure 01. Study locations , zones and aquifer types

In Vavuniya and Anuradhapura all samples showed lesser turbidity below 5 TU. pH of all the wells was in the range of 6.4-7.4. All the wells can be categorized as low salinity water. The thermo tolerant fecal coli form was much higher in some wells near residential areas. Nitrate-N was higher in 20% of the wells above the recommended level of 10 mg/l for drinking water and nitrate-N was low until the beginning of October and has increased after wet season rains in November/December.

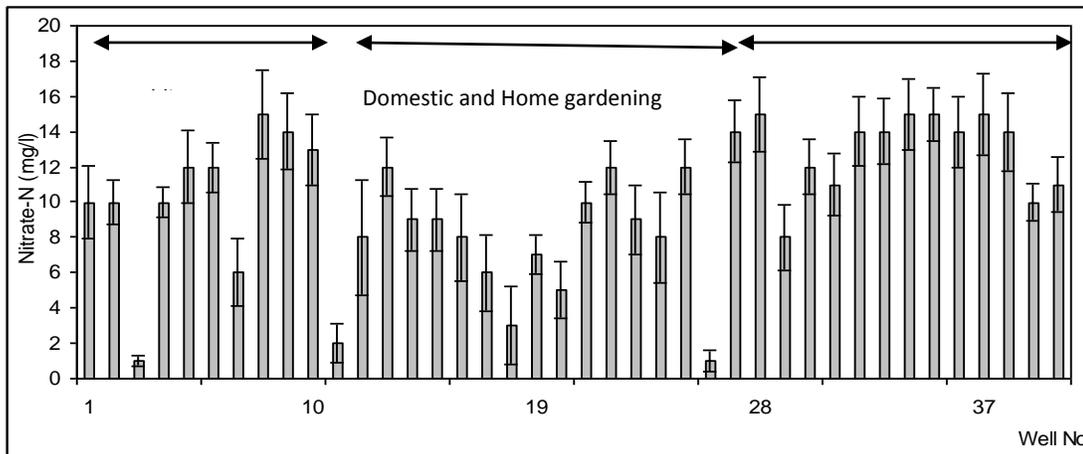


Figure 02: Average concentration of NO₃- N with standard deviation in Jaffna Peninsula.

The ammonium concentration increased after rainfall and exceeded the recommended level of 0.2 mg/l according to World Health Organization (WHO,1995) . In all wells sulphates were below recommended level of 600 mg/l for drinking water (WHO,1995) . Chloride ions were within the permissible limit. The maximum limit of fluoride for insignificant risk (1.5 mg/l), was exceeded

by some of the wells and were in the range of 0.28 mg/l to 1.74 mg/l especially in Anuradhapura (Figure 03). Concentrations above this value carry an increasing risk of dental fluorosis, and much higher concentrations lead to skeleton fluorosis. Research findings showed that the higher concentration of Fluoride may cause even Kidney diseases (Sivarajah, 2003). In most of the study areas, there are a lot of complaints about the hardness of water and kidney ailments, especially during the wet season. Even though, Malsiripura in Kurunagala is an intensively vegetable cultivated area, all the measured parameters were within the permissible limit except for the Nitrate concentration. The wells within the cultivated areas showed a higher value of 8mg/l during wet season where the permissible limit is 10 mg/l.

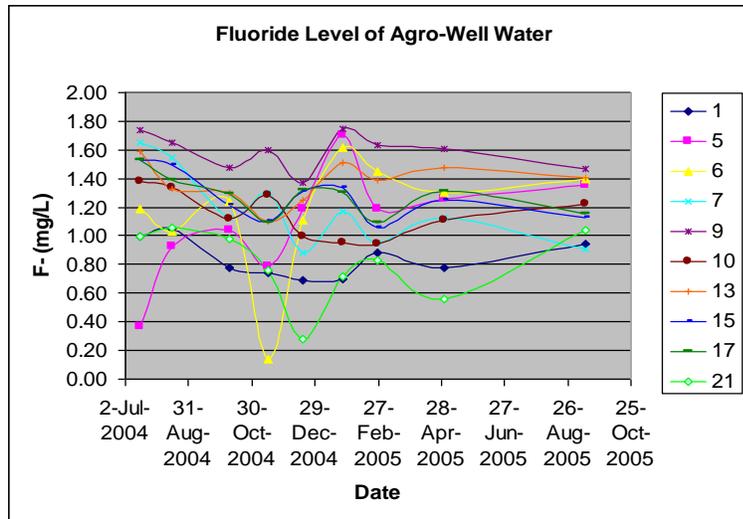


Figure 03: Temporal variation of Fluoride in agro-well water in Anuradhapura

In Hambantota too all the measured parameters were within the permissible limit except for ammonium, nitrate, phosphate and sulphate. The study results showed that 26 % of the wells in the study areas exceeded the permissible limit of 0.06mg/l of ammonium (0.068mg/l). In addition 20% of the wells exceeded the 2mg/l permissible limit of phosphate (2.97mg/L) and 20% of the wells exceed the permissible limit of sulphate during the study period (487mg/l). The maximum permissible level of sulphate is 400 mg/l. Similarly 30% of the sample well water exceeded the permissible limit of 10mg/l (as N) in January at the end of the rainy season (11.1mg/l).

Correlation between agricultural land use and high nitrate concentrations in ground water have been documented since at least the 1970s (Hallberg, 1986). Studies conducted in Jaffna by Nagarajah et al (1982) and in Kalpitiya by Kurippuarachchi (1995) reported about high concentration of nitrate in ground water under different soil conditions. The high concentration of nitrate may also be due to the characteristics of the soil in the study area having sandy loam nature with high porosity compared to clayey soils restricting leaching of nutrients to the shallow ground water (De Silva and Ayomi, 2004).

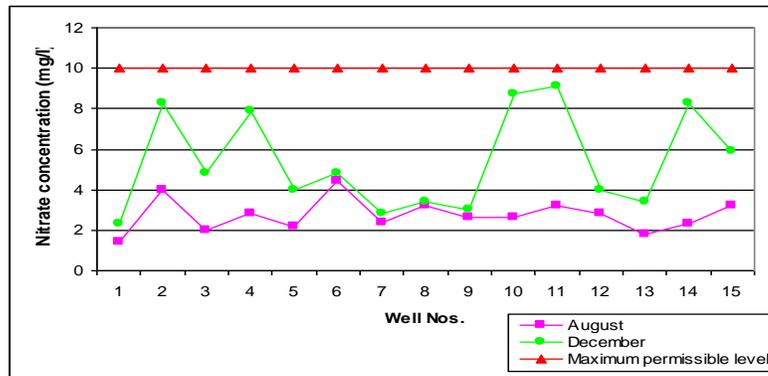


Figure 03. Variation of Nitrate concentration in Hambantota wells

CONCLUSIONS

Groundwater quality assessment was carried out in intensive agricultural activity areas in Jaffna, Vavuniya, Anuradhapura, Kurunagala and Hambantota to study the suitability of shallow groundwater in agro-wells for domestic and drinking purposes following the complaints made by the community on kidney related ailments such as Chronic Kidney Disease (CKDu), diarrhoeal and other water related diseases. Results of all the study areas on several parameters showed that the agro-well or shallow well (6m-10 m deep) water is not suitable for drinking and domestic purposes. Complaints are more during the wet season as the salts and other elements in the soil are washed to the well water due to wet season rains. However, there is no proof to show that the higher nitrate or fluoride or any compound of mixture of heavy metals such as Cadmium and/ or Arsenic is the actual cause for kidney and other health related issues among the community. But it is very clear that the well water from shallow wells (less than 10m) in dry and intermediate zones is not suitable for drinking and domestic purposes. Unlike rivers, aquifers do not have any self cleansing capacity especially with respect to aeration. Hence, once polluted they remain polluted for long periods. Therefore, all the households using shallow wells in these zones must be encouraged to use rainwater collected by a recommended rainwater harvesting system until the water supply is provided for this community for drinking and domestic purposes.

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COMPARATIVE STUDY OF DANXIA AND CLAAS COMBINES AT TWO DIFFERENT LOCATIONS IN HARVESTING LD-365 RICE VARIETY

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INTRODUCTION

Harvesting is a crucial operation in rice cultivation. Manual harvesting of rice is a troublesome, time consuming and costly operation since it needs about 100-150 man-hours of labour to harvest one hectare of paddy field. In these conditions, contracting combine harvesters would be an effective solution to reduce production cost and enhance labor productivity. Recently, the use of combine harvesters has been increased enormously in paddy harvesting and numerous brands of combine harvesters are available in the market.

But, there is a concern among the farmers that the performance of combine harvesters differ based on their type and brand. However many studies have reported that the performance of the combines depends on the operating conditions of the combine harvesters as well as the field and crop conditions. Therefore, an attempt was made to study the performance of different types of combine harvesters in different fields while harvesting which will be helpful to understand their operations with respect to real field conditions. Therefore, this study aimed to investigate some technical and field aspects of real field harvesting conditions and to compare them in view of their header losses and performances in two different field conditions.

METHODOLOGY

The study was carried out in Batticaloa during *Yala*, 2012. In order to perform the comparative tests, farmers' paddy fields located at Chenkalady and Pankudavely areas were selected where Danxia 2200 (tine bar reel with the header width of 2 m) and Claas-crop tiger 30 combine harvesters (tine bar reel with a width of 2.1 m) were in operation, respectively. The two combine harvesters were compared in harvesting LD-365 paddy variety at different grain moisture contents and different forward speeds in these two field conditions. The observed crop characteristics of LD-365 variety and the field conditions at the two sites have been given in Table 1.

Table 1. Agronomic traits of LD-365 variety and the field conditions at harvest

Location	Combine used	Grain moisture content (wb)	Plant density Nos /m ²	Soil cone index (kg/cm ²)
Chenkalady	Danxia	22.85±2.47	113±9.08	1.28±0.13
Pankudavely	Claas	19.16±1.92	230±5.12	2.11±0.17

The operators were allowed to adjust the combine harvesters based on the field conditions. To get real data, the operators of combine harvesters were not aware about the experiment. Some important operating parameters in terms of header losses were measured while the combine harvesters were harvesting the paddy. Selected machine parameters were determined using the methods given in Table 2. In each location, performance parameters of combine harvesters were measured in three plots which included travel speed, lost time and total required time. Almost three similar size plots were selected in each field to determine the header losses and field performances of the combines. Theoretical field capacity, effective field capacity and field efficiency of the tested combine harvesters were obtained from the formulae reported by Hunt, 1995. Theoretical field capacity is the rate, in ha/h, at which a machine is working when no time is lost due to turns, unused width, stopping, plugging, breakdowns etc. The area covered is

divided by the total time (effective harvesting time plus non productive time). Field efficiency is the ratio of the actual field capacity of a machine to its theoretical capacity. The tine bar velocity of each combine was determined as reported by Oduori *et al.*, 2008.

At steady-state speed of the combine harvesters, they were suddenly stopped and a steel frame of 0.5m² was placed in front of them. The header losses were determined by picking the fallen grains and the panicles inside the area confined by the steel frame at random locations of each plot in the two selected paddy fields. Three sample areas of 0.5m² size each were randomly selected from the experimental fields and the average yield of rice was calculated as reported by Qamar-uz-Zaman *et al.*, 1991. Then, weight percentages of header loss were computed by the formula reported by Pradhan *et al.*, 1998. Two sample *t* test was used to analyze the header losses from the machines using MINITAB.

Table 2. Measurement of crop and machine parameters

Parameters	Method of analysis
Grain moisture content	'Satake' grain moisture meter
Reel rotational velocity	Stop watch and counter
Cutter bar pulley speed	Tachometer (HIOKI 3404)
Speed of combine harvester	Stop watch and measuring tape
Height of cutter bar and reel diameter	Measuring tape (steel)
Height of the reel axis above the ground	Measuring tape (steel)

RESULTS AND DISCUSSION

The results from the machine losses indicate that there is a difference between the combine harvesters with respect to header losses as the working age of machine, operator's skills, field condition, grain moisture content etc. were different. A comparison of the header losses demonstrated that the mean header losses from Danxia was 11.4 kg/ha (0.22% of total grain yield of 5152.1 kg/ha) whereas it was found to be 16 kg/ha (0.28% of total grain yield of 5608.1 kg/ha) for the class combine harvester under the tested field conditions (Figure 1). The variation in header losses from these two combine harvesters could be explained in five categories such as the forward speed, the tine bar velocity, cutter bar speed, the grain moisture content and plant density.

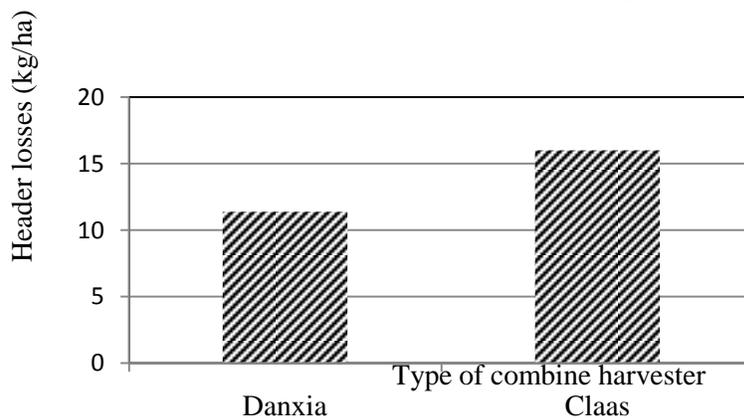


Figure 1 Comparison of the header losses from two types of combine harvesters.

The major observed operational conditions of combine harvesters that the operators selected during harvesting LD-365 paddy variety are given in Table 3. The minimum header losses noticed for Danxia could be due to its lower forward speed of 1.116 km/h compared to Claas which was operated at 3.096 km/h. A relatively lower forward speed of Danxia offered gentle handling of the panicles in cutting and conveying processes which resulted in decreased header losses. Generally, the increase in speed was found to increase the header losses, which is in line with the findings of Fouad *et al.* 1990 and Schueller and Bac 1984.

Table 3. Operational parameters of the tested combines in harvesting LD-365 paddy

Parameter	Danxia 2200	Claas – Crop tiger 30
Width of cutter bar (m)	2.0	2.1
Cutter bar speed (m/s)	0.14	0.56
Forward speed (km/h)	1.116	3.09
Height of cutter bar (cm)	10.1	23.5
Tine bar velocity (m/s)	1.1	2.35

The variation in header loss could also be attributed to the variation in magnitude of impact velocity of tine bar. The impact velocity caused by the header unit of Danxia was 1.1 m/s whereas it was 2.35 m/s in Claas combine harvester relative to their forward speeds under the two different field conditions. This has been approved by an investigation by Oduori *et al.* (2008) that the shattering or header losses are mainly due to the impact velocity of the tine bar. In general, loss could be attributed to harvest time, type of variety and its physical properties, crop condition in terms of maturity, lodging and soil condition. The differences between the combine harvesters with respect to header losses can also be due to the working age of machine, operator skills and field topography etc.

It has also been reported that the cutter bar speed affects the header loss. The header loss increases with increasing cutter bar speed (Chaiyan Junsiri and Winit Chinsuwan. 2009). The cutter bar speed of 0.56 m/s in Claas combine harvester at Pankudavelly might have caused a violent vibration at the header which had a severe impact on the stems and caused grain loss. But in contrast the cutter bar speed of 0.14 m/s the losses were found to be minimal from Danxia. Having the mean grain moisture contents of 22.85% at Chenkalady and 19.16% at Pankudavelly accounted for the observed lower losses at Chenkalady with Danxia than that of at Pankudavelly with Claas. This observation indicated that the effect of grain moisture content was considered to have higher header losses as it is inversely related to grain moisture. This conforms to the study of Chinsuwan *et al.* (1997) that high-moisture content or fresh paddy tends to cling to the head firmly and their rate of falling was less than low-moisture or dry grains. As the grain moisture decreased, the losses increased, because the stalks at lesser grain moisture were more frequently broken causing the grains to shatter before being elevated to the threshing drum. This finding also relates to Quick (1972) and Clark and De Pauw (1983).

Further, the plant density at Pankudalvely was found to be higher than that at Chenkalady which might have facilitated for the shattering of more grains per unit area. This is in conformity with the findings of Lien *et al.*, (1976) that the header losses were found to be a function of forward speed, plant population and lodged stalks.

The result from the *t* test shows that the losses from Claas combine harvester operated at the field conditions of Pankudavelly is significantly higher than the losses from Danxia combine harvester operated at the field conditions of Chenkalady ($P = 0.02$). However, this significant difference in losses is due to the combination of machine operational and crop conditions. Therefore, further

studies are needed to find out the effect of individual operational parameters of the combine harvesters.

Table 4. Field performance of Danxia and Claas combine harvesters

Parameters	Danxia	Claas
*Area of plot harvested (ha)	0.0284	0.0296
*Total harvested time (min)	16.33	11.18
*Actual harvested time (min)	7.71	7.21
Effective field capacity (ha/h)	0.104	0.159
Theoretical field capacity (ha/h)	0.27	0.65
Field efficiency (%)	47.2	64.5

*Mean of three replicates

Comparison between field performances of harvesting machines is shown in Table 4. These two combine harvesters cannot be compared in terms of field capacity since they differ in the width of cut (Fouad *et al.* 1990). Therefore, they are compared in terms of their field efficiency which is mainly affected by the loss of times while harvesting. Field efficiencies were found to be varied from 64.5% for Claas combine harvester to 47.2% for Danxia. The higher field efficiency of Claas was due to its smooth operation without clogging at the forward speed of 3.09 km/h but Danxia combine underwent minor repairs during harvesting so that the total time required for harvesting was found to be greater. This caused lower field efficiency at the forward speed of 1.116 km/h. This implies the failure to utilize the theoretical operating width of the combine harvester due to greater idle time in harvesting.

CONCLUSION

In addition to the machine operational parameters, the header losses were also influenced by the crop conditions as well. The header losses were significantly higher from Claas combine harvester when compared to Danxia combine harvester under these two different field conditions. Even though the header losses were greater from Claas, its performance in terms of field efficiency (64.5%) was acceptable. However the percentage of header losses of total grain yield from both combine harvesters were less than 0.3% which can be considered as minimum. The direct comparison of these two combine harvesters is precluded as their operational conditions including the field conditions, operator's capability, crop density, grain moisture content were different.

RECOMMENDATION

The operational parameters of the combine harvesters should be selected in consideration of the crop conditions to reduce the header losses.

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IMPACT OF MULCH ON GROWTH PARAMETERS OF TOMATO (*solanum lycopersicum*-Variety *thilina*) PLANTS EXPOSED TO HIGH TEMPERATURE AND WATER STRESS

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INTRODUCTION

Studies in Sri Lanka based on HadCM3 general circulation model has revealed that the temperature will increase in the coming years and in 2050s the highest temperature increase by 2⁰ C is predicted in Anuradhapura compared to the baseline temperature during the period of 1961-1990. Further the rainfall during northeast monsoon is predicted to decrease in the dry zone area. Therefore, the decrease in rainfall and increase in temperature will increase the evapotranspiration and soil moisture deficits. Accordingly, agricultural activities in the dry zone may be affected by predicted climate change in Sri Lanka (De Silva et al., 2007). A significant change in climate on a global scale will impact agriculture and consequently affect the world's food supply. Climate change per se is not necessarily harmful; it is the problems that arise from extreme events that are difficult to predict (FAO 2001). More erratic rainfall patterns and unpredictable high temperature spells will consequently reduce crop productivity. Temperature stress is becoming the major concern for plant scientists worldwide due to the changing climate. The difficulty of climate change is further compounded considering its precisely projecting potential agricultural impacts. Temperature stress has devastating effects on plant growth and metabolism, as these processes have optimum temperature limits in every plant species. Water deficit often limits the crop growth and development. The plant is sensitive to water stress. Plant seedlings cannot withstand either water deficit or excess soil moisture while older plants can withstand deficit or excess water. To improve the productivity of crops where either water deficiency or excess frequently occurs, proper water management is necessary (Hale and Orcutt, 1987). The conservation of soil moisture may help in preventing the loss of water through evaporation from the soil facilitating maximum utilization of moisture by the plants. Mulching is a method by which soil moisture can be conserved (Sandal and Acharya, 1997). Mulching stimulates the microbial activity in soil through improvement of soil agro-physical properties. This study intends to identify a suitable mulch to mitigate consequences of higher temperature and water stress by evaluating the growth parameters of Tomato (*Solanum lycopersicum*) variety Thilina. Tomato is one of the most widely cultivated crops through the year both during *yala* and *maha* seasons. In a previous study the tomato plants grown under temperature and water stress were not successful as the plants were unable to cope with higher temperature and water stress effects (Gunawardana et al, 2011).

MATERIAL AND METHODS

Growing conditions

The research is planned to identify effect of mulch on temperature and water stress due to climatic changes on dry zone vegetables with the most popular variety of Tomato. First season (1st) study was conducted during December 2012 and an experiment was set up in the agricultural field poly tunnels of Open University at Nawala, Nugegoda.

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Nursery management was initiated on 18th December in 2012 and Tomato seedlings were transplanted (28th December 2012) into individual plastic pots (1 plant/ pot in 30 cm i.e. and 45 cm deep pots). The pots were filled with a compost and sandy loam soil mixture and the two mulching treatments namely coir dust, saw dust with control treatment was unmulched (no mulch) were arranged in a complete randomized design. Two mulches were added for 5cm thickness until the surface of the compacted soil was within 1.5 cm of the rim. Initial height of the Tomato seedlings was 12 cm. These Tomato plants were grown at 3 different conditions as indicated in the Table1.

A two factor factorial experiment was carried out under three replicates. Pots are arranged according to the complete randomized design (CRD), resulting in a total of 54 pot-grown plants. Temperature and mulches were taken as factors. Physiological and morphological parameters of Tomato were investigated during the growing and reproductive periods. Analysis of variance (ANOVA) of the result was performed using the statistical program Minitab (version 14, Minitab Inc.), followed by (P = 0.05).

Table 01. Three different environment at condition of the experiment.

No	Environmental conditions
Condition 1 – Open Top Poly tunnel	Temperature of 32 °C (i). Providing adequate water to fill the field capacity for Tomato plants in mulching pots. (ii). Providing water to fill only the 50% of the field capacity for Tomato plants in mulching pots.
Condition 2 – Open Top Poly tunnel	Temperature of 34 °C (i). Providing adequate water to fill the field capacity for Tomato plants in mulching pots. (ii). Providing water to fill only the 50% of the field capacity Tomato plants in mulching pots.
Condition 3 – Open space	Ambient temperature [AT ⁰ C] (i). Providing adequate water to fill the field capacity for Tomato plants in mulching pots. (ii). Providing water to fill only the 50% of the field capacity for Tomato plants in mulching pots.

RESULT AND DISCUSSION

Temperature and water stress on morphological parameters of Tomato

Plant height

Plant height was measured from 30 Days after Transplanting (DAT) to 105 DAT at 15 days interval. As shown in Figure. 1, the plant height varied significantly due to different mulches and temperature at different growth stages and increased with plant age. Coir mulch in 34°C maximum temperature treatment showed the superior performance in plant height than the control without mulched, indicating mulches had positive effect on the growth and development of Tomato. The increased plant height in mulched plants may be possibly due to better availability of soil moisture and by reducing the effect of higher temperature.

Leaf area

The mulches had a significant effect on the leaf area of the plant. The leaf area continually increased with plant age. All the mulches had a positive effect on generating and retaining higher

leaf area per plant. The highest leaf area per plant was observed in saw dust mulch in no water stress treatment of 32°C maximum temperature. Control treatment without mulch always showed the lowest leaf area per plant in all temperature treatments. Favorable weather condition and moisture of the soil are the important parameters affecting the leaf area of plant. It was reported that mulched Tomato plants had more leaf area and branches than that of plants without mulch, which supported the present results.

Temperature and water stress on physiological parameters of Tomato

Leaf chlorophyll content

Chlorophyll concentration has been known as an index for evaluating source strength thus, its decrease under drought stress can be regarded as a non-stomatal limiting factor. There are reports showing the decrease in chlorophyll under drought stress (Kulshreshta et al., 1987). The effect of mulch on leaf chlorophyll content is presented in Figure 04. Results revealed that the no water stress plants have more chlorophyll content than the water stressed plant in all three temperature conditions. The saw dust mulched plants at 32°C temperature showed significantly higher chlorophyll content.

Figure. 01. Effect of mulching on average plant height.

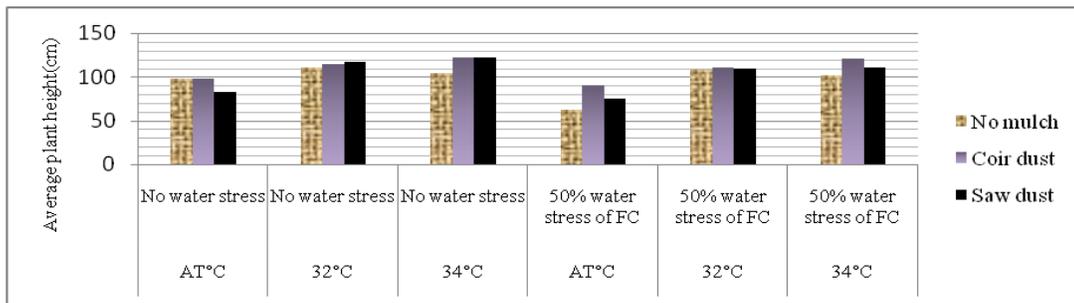
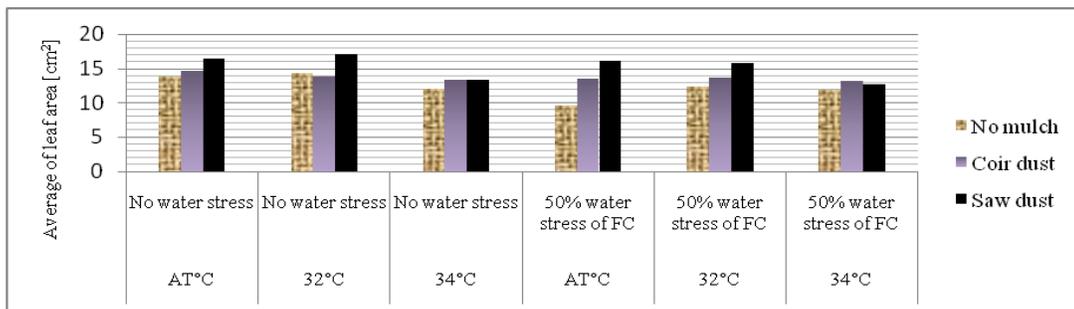


Figure.02. Effect of mulching on the average leaf area.



Relative Water Content (RWC)

Measurements of water content expressed on a tissue fresh or dry mass basis have been mostly replaced by measurements based on the maximum amount of water a tissue can hold. These measurements are referred to as Relative Water Content (Barrs, 1968). These results show that organic surface mulches can improve internal water status. Generally RWC of the plants maintained without water stress is higher than the water stressed plants. However RWC is significantly higher in coir dust and saw dust mulches in higher temperatures.

Figure.03 Effect of mulch on average chlorophyll content

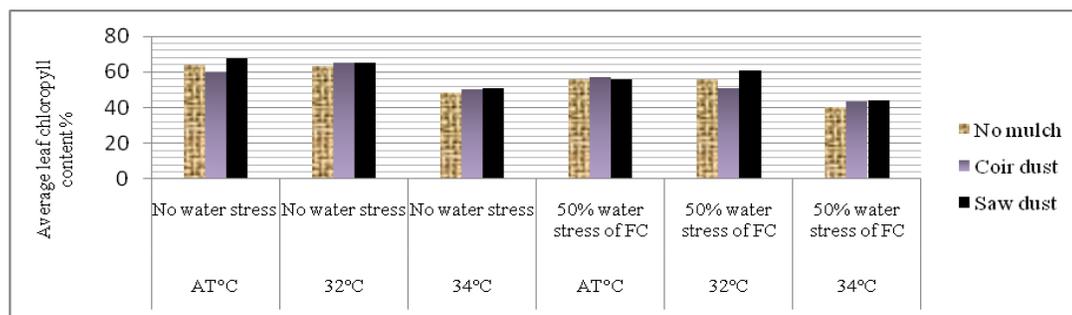
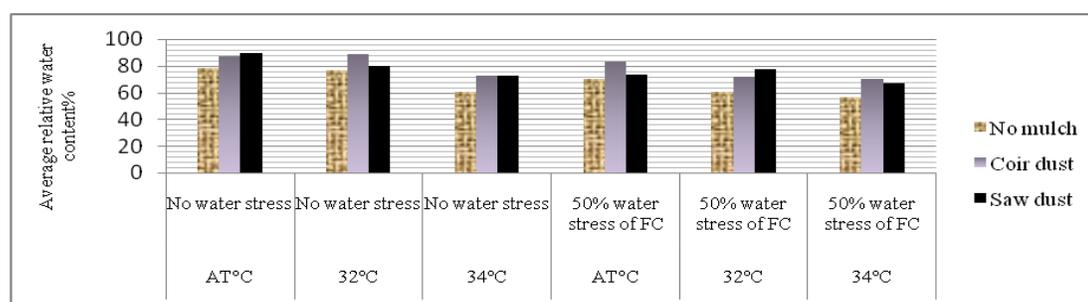


Figure.04. Effect of mulch on average relative water content



CONCLUSION

According to the results, there is significant effect of mulch on growth parameters of Tomato plants exposed to water and temperature stresses. Higher temperature treatments with saw dust mulch showed significantly higher plant height. Higher leaf area was shown on 32^oC with no water stress condition. The water stress resulted in significant decreases in chlorophyll content and the leaf relative water content. (Kirnak et al., 2001) showed that the total chlorophyll content in high water stress was reduced by 55% compared to the control which agrees with present results. Water and temperature stress in combination had severe negative effects on growth parameters as compared to the mulched treatments. According to high temperature stress of 32-34^oC could minimized by using mulches such as saw dust and coir dust. There were significant good growth parameters under saw dust mulch in maximum temperature of 32^oC and under coir mulch in 34^oC maximum temperature. Agronomic management practices like mulching will help the crop to adjust to the climatic change in Sri Lanka.

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**IMPACT OF MULCH ON YIELD AND QUALITY PARAMETERS OF TOMATO
(*Solanum lycopersicum*-variety Thilina) PLANTS EXPOSED TO HIGH TEMPERATURE
AND WATER STRESS**

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INTRODUCTION

Agricultural crops are affected by climate change due to the relationship between crop development, growth, yield, CO₂ atmospheric concentration and climate conditions. Temperature related extreme indices have increased over most locations in Sri Lanka. Annual average rainfall over Sri Lanka has been decreasing for the last 57 years at a rate of about 7 mm per year. The coefficient of variation of rainfall distribution between 1931 and 1960 is greater during the Northeast monsoon and Second inter monsoon period (*Maha* Season) when compared to the period from 1961 – 1990. Southwest monsoon rainfall has not shown any significant change during these two periods. However variability has decreased during 1961-1990 compared to 1931-1960 period. When temperature exceeds the optimum for biological processes, crops often respond negatively with a steep drop in net growth and yield (Chynthia Rosen Zweig and Hillel, 1995). Some reports show that an increase in temperature by a single degree above normal can lead to a significant reduction in growth and yield (Pastori and Foyer, 2002). Yield is positively related to the amount of incoming solar radiation intercepted by the plants in a long season crop. Shading reduces the fruit size (Kinet & Peet, 1997), and low light intensities combined with low temperatures cause deterioration of fruit taste caused by a decrease in sugar content (Rylski et al., 1994). Termination of growth of small fruits is sometimes induced by high temperatures and high light conditions. Tomato is one of the major fruit vegetables in the world. In Sri Lanka it is annually cultivated in more than 220ha, producing approximated 3400metric tons. However, the average productivity of Tomato in Sri Lanka (2 metric tons/ha) is much lower than the world average as the seasonal weather changes adversely affect average productivity. In the meantime, a shortage in the month of peak rain fall (May and November) and a production glut in the month of harvesting (March to May and September to October) lead to a dichotomy in the distribution of annual Tomato production. Protect culture is a remedy for environmental problems of crops cultivation. However, seasonal weather changes adversely affect indoor grown plants. Protected (indoor) culture is predominately used in temperature regions. In Sri Lanka, commercial growers of ornamental plant or vegetable crop use different types of indoor structure and agronomic management practices which provide protection at a different level.

This study intends to identify a suitable mulch to mitigate consequences of higher temperature stress on soil by evaluating the yield parameters of Tomato [*solanum lycopersicum*] variety Thilina as it is widely cultivated throughout the year both *yala* and *maha* seasons. Plants cultivated without mulch under higher temperature and water stress were unsuccessful with very low yield (Gunawardana et al, 2013).

MATERIAL AND METHODS

Growing conditions - The research is planned to identify effect of mulch on plants' exposure to temperature and water stress due to climatic changes on one of the dry zone vegetables with most popular variety of Tomato. The study was conducted during December 2012 and an experiment was set up in the agricultural field poly tunnels of the Open University at Nawala, Nugegoda.

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Nursery management was initiated on 23rd December in 2012 and tomato seedlings were transplanted (18th December 2013) into individual plastic pots (1 plant/ pot in 30 cm i.e. and 45 cm deep pots). The pots were filled with a compost and sandy loam soil mixture and the two mulching treatments namely coir dust, saw dust with control treatment was without mulch (no mulch) were arranged in a complete randomized design. Two mulches were added up to 5 cm thickness until the surface of the compacted mulch and soil was within 1.5 cm of the rim. Initial height of the Tomato seedlings was 12 cm. This Tomato plants were grown at 3 different conditions as indicated in the Table 01.

The experimental design was Completely Randomized Design (CRD) with factorial treatment structure. Stress and mulches were taken as factors, resulting in a total of 54 pot-grown plants yield and quality parameters of Tomato were investigated during the fruit ripening stage. All extraction runs and analyses were carried out at least in duplicate and in randomized order with the mean values being reported. Analysis of variance (ANOVA) of the results was performed using General Linear Model procedure of Minitab (Software Version 14). Significant differences specified were all at $p < 0.05$.

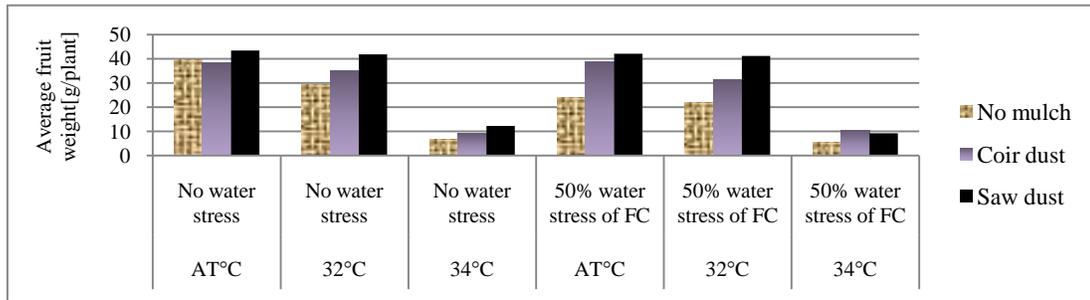
Table 01. Three different environment at condition of the experiment.

<i>No</i>	<i>Environmental conditions</i>
Condition 1 – <i>Poly tunnels</i>	<u>Temperature 32°C</u> (i). Providing adequate water to fill the field capacity for Tomato plants in mulching pots. (ii). Providing water to fill only the 50% of the field capacity for Tomato plants in mulching pots.
Condition 2 – <i>Poly tunnels</i>	<u>Ambient temperature 34°C</u> (i). Providing adequate water to fill the field capacity for Tomato plants in mulching pots. (ii). Providing water to fill only the 50% of the field capacity Tomato plants in mulching pots.
Condition 3 – <i>Open space</i>	<u>Ambient temperature [AT°C]</u> (i). Providing adequate water to fill the field capacity for Tomato plants in mulching pots. (ii). Providing water to fill only the 50% of the field capacity for Tomato plants in mulching pots.

RESULTS AND DISCUSSION

Fruit weight

Fruit weight decreased with increase in temperature irrespective of water availability. Plants grown in an ambient temperature without a water stress showed the highest fruits weight (Figure 01). Fruit weight statistics showed that there is significantly higher ($p < 0.05$) impact in outdoor ambient temperature compared to 32°C and 34°C temperature ranges inside the poly tunnel. High temperatures however often result in smaller fruits. But significant results were presented on saw dust mulching in 32°C temperature. In the case of dry matter of the fruit the maximum weight was observed at the 34°C temperature with water stress and no mulched condition.

Figure 01. Effect of treatments on average fruit weight.

Even the combined effect of high temperature and water stress had a remarkable effect on the fruit weight of Tomato compared to the other treatments. Sawdust mulch performed well in both water stressed and no water stress condition irrespective of temperature. However fruit weight was lowest in 34°C treatments.

Soluble solids content (SSC)

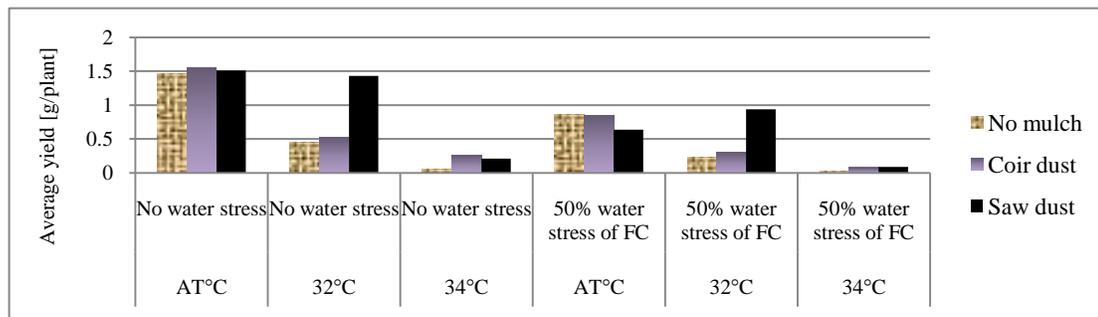
SSC of Tomato tested ranged from 6.43 to 11.06 °Brix. SSC increased with increased temperature irrespective of water availability. However, 34°C maximum temperatures showed the highest SSC irrespective of water availability. May (1993) observe that low water stress resulted in maximum yield of Tomato raw product with best viscosity and soluble solids. High water stress caused lower yield, highest soluble solids and poorer viscosity. Soluble solids were highest in no mulch and no water stress condition.

Firmness

Fruit firmness is determined by a number of factors including cell wall structure and cuticle properties. Flesh firmness is a characteristic used to indicate fruit quality. During Tomato ripening, remodeling and degradation of the cell wall is intimately involved in softening (Matas et al., 2009). Tomato has been identified that have a global effect on ripening and texture. The effects of humidity and temperature on firmness of Tomato were studied to discriminate between the effect on the biochemical process of cell wall breakdown and the effect on the physical process of water loss. Average firmness of fruit among the treatments increased with increase in temperature. It was also observed that no mulch conditions has the highest firmness followed by saw dust and coir dust Coir mulch and saw dust mulch presented significant effect ($p < 0.05$) on tomato fruit firmness. Firmness is one of the important factors determining market quality and consumer acceptance of tomatoes.

Fruit yield

According to the results the average yield decreased with increase in temperature (Figure 02). Results showed that the highest mean yield (1.55kg/ plant) in plant grown in outdoor ambient temperature without water stress with coir dust mulch followed by saw dust mulch. The potential yield range of Tomato with the application of recommended chemical fertilizer was 20 to 30 t/ha (Department of Agriculture Crop recommendation – Technogide). Therefore, above yield of Tomato in ambient temperature (outdoor condition) without water stress is in the potential yield range of Tomato. Although the vegetative growth is higher in the controlled environment condition, at 32°C temperature and saw dust mulch, the yield was in significant value (1.43kg/plant) and with water stresses it was further reduced to (0.94kg/plant). Meanwhile the yield obtained at 34°C temperature and coir mulch with no water stress was 0.26kg/plant. But in the previous research without mulching showed only 0.16kg/ plant was obtained at 34°C with no water stress (Gunawardena et al, 2011). This study proves that the yield can be improved with mulching even if the temperature increased up to 34°C due to global warming if the plants are maintained with no water stress.

Figure.02. Effect of treatments on average fruit yield of Tomato

CONCLUSION

According to the results, there is significant effect of individual stress of water, mulching and temperature and in combination effect on yield parameters such as fruit firmness, fruit SSC, fruit weight, fruit yield etc. The fruit firmness and SSC increased with increase in temperature. But the average fruit weight and average yield per plant decrease with increase in temperature. According to the results there is not much difference between the water stress and no water stress treatment as the mulching has resisted the effect of temperature by conserving more moisture in the soil. Mulch and water stress; two way interactions were significant ($p < 0.05$) 32°C and 34°C temperatures in SSC. Fruit weight had significant ($p < 0.05$) value in two way interactions of 34°C. Therefore the yield per plant has improved with coir dust mulch compared to the previous study without mulch at 34°C maximum temperature. The findings of this study could be an adaptation measure for farmers growing tomato if the temperature increases due to global warming. This study will be continued to reconfirm the findings.

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IMPACT OF MULCHING ON SOIL PROPERTIES TO COPE WITH TEMPERATURE STRESS BY MAIZE PLANTS (*ZEA MAYS L.*)

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INTRODUCTION

Global warming, driven by the rising of greenhouse gases especially CO₂ in the Earth's atmosphere, could cause many changes to the ecosystems of the world. One of the most important is a long-term shift or alteration in the climate termed as "Climate Change". Temperature and precipitation are the most important climatic parameters for crop growth. Therefore, scientists have used available climatic data and information into several large-scale models on the atmosphere. These models are used to predict changes in temperature, precipitation, radiation, like climatic variables caused by increased greenhouse gases in the atmosphere. Temperature increase during 1961 to 1990 has been reported for Colombo as 0.0164°C per year and Anuradapura 0.0364°C per year (Fernando and Chandrapala 1995). The average annual temperature for 2050 using General Circulation Model (HadCM3) predicts an increase by 1.6°C (A2 scenario) and 1.2°C (B2 scenario). The highest mean temperature predicted for Anuradhapura was 2.1°C (A2), 1.6°C (B2). During the southwest monsoon period (May to September) the overall increase in mean annual air temperature across the island is predicted to increase by 1.6°C (A1) and 1.2°C (B2) (De Silva, *et al* 2007). Further the Northeast monsoon rainfall is also predicted to be decreased.

Maize is one of the main crops widely cultivated in the dry zone of Sri Lanka. Mulching can affect the temperature and moisture content of the soil. Mulching increased soil moisture, organic matter contents leading to a suitable environment for root penetration. The soil organic matter is increased due to decomposition of applied mulch. Applications of crop residue mulches increase soil organic carbon contents.

Therefore this paper analyses the impact of mulch on soil properties by analyzing the growth and yield of Maize plants grown under temperature and water stress.

MATERIALS AND METHODS

This study was conducted from October 2010 to December of 2012 in two temperature regulated poly tunnels constructed in the agricultural field of the Open University of Sri Lanka, Nawala, and Nugegoda. One was maintained at 32°C maximum temperature and the other at 34°C (Temperature was maintained by using temperature regulating sensors). The cultivar sampath of maize was used for testing and Maize seeds were directly planted in individual diameter of 45cm plastic pots (each pot contains one plant). The pots were filled with a compost and reddish brown earth soil mixture. Plants were grown under 3 different conditions as indicated in Table 01. Management of the crop, cultural practices and fertilizing were done according to the recommendations of the Department of Agriculture. All the plants were watered to the field capacity level (determined using pressure plate apparatus) of the soil in order to avoid water stress. The experimental design was Completely Randomized Design (CRD) with factorial treatment structure. Temperature and mulches were taken as factors. Physiological and morphological parameters of Maize were investigated during the growing and reproductive periods.

Plant height was measured at weekly intervals 10 WAP. Yield was collected two times during

the growing season and the average of two pluckings was taken as yield per plant. **Soil moisture content under different mulches** was measured within 3 -10 cm depth, at 10 WAP using the gravimetric method. Soil pH was measured using an electronic pH meter whereas the electrical conductivity using the conductivity meter, ASTM D 2974 Ignition method was used to determine the Organic Matter content in the soil using a Muffle furnace. Soil P and K Content were determined spectrophotometrically. All extraction runs and analyses were carried out in duplicate and in randomized order with the mean values being reported. Analysis of variance (ANOVA) of the results was performed using General Linear Model procedure of SPSS (Software Version 19). Multiple comparison of the various means were carried out by LSD (Least Significant Difference) test at $P = 0.05$ and $p = 0.01$.

Table 01: Three environment conditions maintained for the experiment

Condition	Major Specifications
Condition 1 – Poly Tunnel	34 ⁰ C Poly tunnel Three types of mulches on soil – coir dust (M1) /straw (M2)/sawdust (M3)/No mulch(M0)
Condition 2 – Poly Tunnel	32 ⁰ C Poly tunnel Three types of mulches on soil – coir dust (M1) /straw (M2)/sawdust (M3)/No mulch(M0)
Condition 3 – Open Space	Ambient temperature Three types of mulches on the soil – coir dust (M1) /straw (M2)/sawdust (M3)/No mulch(M0)

RESULTS AND DISCUSSION

Pod yield

The pod yield is the most important character when considering the economic importance of this crop. Coir dust mulch showed a significantly high yield compared to the other mulches under all three temperature conditions (Table 02). Higher air temperatures will also be felt in the soil, where warmer conditions are likely to speed the natural decomposition of organic matter and to increase the rates of other soil processes that affect fertility. Further, when temperature exceeds the optimum for biological processes, crops often respond negatively with a steep drop in net growth and yield (Cynthia Rosenzweig and Daniel Hillel 1995). It shows that coir dust mulch resist temperature stress on maize yield.

Soil pH

Average soil pH among the treatments ranged from 6.5 -7.24 (Table 02). Generally, plants mulched with saw dust maintained significantly higher pH values than the others. Soil pH was lower in soils mulched with coir and straw than no mulch and saw dust.

Soil electrical conductivity

Average soil EC among the treatments ranged from 9 -11.6 (Table 02). Generally, agricultural management practices can change the characteristics of the soil surface and influence the hydrothermal properties of the soil. For example, mulching can affect the temperature and moisture content of the soil (Cynthia Rosenzweig and Daniel Hillel 1995). The highest EC was reported from coir dust mulch treatment. EC is proportionally increased with the moisture content. Coir dust mulch treatment increases the soil moisture content in soil according to the retardation factor.

Organic matter content

The highest organic matter content was reported from saw dust in 34°C and in ambient temperature treatments. In 32°C temperature condition, dust showed the highest organic matter content. The lowest organic matter content was shown by no mulch condition under all temperature conditions (Table02). Organic matter is a key component of soils affecting their physical, chemical and biological properties and is important as a source of energy and nutrient elements for soil ecosystem. Maintenance of sufficient levels of organic matter in soils is a prerequisite for sustainable and high production of crops according to Arafat (1994).

Table 02: Variations of Crop and soil characters among the treatments (10WAP)

Treatments	Yield/plant (g)	pH	EC (ds/m)	Organic matter (%)	Soil moisture (%)	K (ppm)	P (mg/kg)
Ambient tem-no mulch	81	6.6	9.9	3.1	20	149	17.5
Ambient tem-coir	142	6.5	10.7	3.8	25	165	21.5
Ambient tem-straw	114	6.4	9.9	3.4	22	151	17
Ambient tem-saw dust	101	6.7	9.6	3.3	24	166	21
32 °c max tem-no mulch	95	6.7	9.8	2.8	19	160	19
32 °c max tem-coir	135	6.5	11.7	3.9	23	177	23
32 °c max tem-straw	107	6.5	9.9	3.5	24	161	20
32 °c max tem-saw dust	106	7.2	9.6	4.2	22	170	22
34 °c max tem-no mulch	104	6.9	11.5	2.5	17	140	17.5
34 °c max tem-coir	124	6.5	11.7	4.8	23	159	22.5
34 °c max tem-straw	88	6.6	9.8	3.5	21	158	19
34 °c max tem-saw dust	95	6.7	9.2	3.2	24	156	21

Some of the properties influenced by organic matter include soil structure, soil compressibility and shear strength. In addition, it also affects the water holding capacity, nutrient contributions, and biological activity, water and air infiltration rates. Research findings indicate the vital role of bio-organic fertilization in more release of available nutrient elements to be absorbed by plant roots and this in turn increase dry matter content in the different peanut and lentil plant organs.

Moisture content

Average soil moisture among the treatments ranged from 18%-25%. According to the results there was no significant difference with temperature. Significant variation was shown between coir dust and no mulch condition. The highest moisture percentage was reported from coir dust and saw dust mulched treatment followed by saw dust mulched treatments and lowest moisture percentage was shown from no mulch condition. Therefore mulching will help to maintain the high moisture content.

Soil Phosphorus content

Average soil phosphorus among the treatments ranged from 17 – 23 mg/kg (Table 02). According to the results there is no significant difference among the mulches. Significant variation was shown between coir dust and no mulch condition. The highest soil phosphorus content was reported from coir dust and saw dust mulched soil in ambient temperature condition. In temperature stress (32°C) condition coir dust mulched soil showed the highest soil phosphorus and lowest soil phosphorus content was shown from no mulch condition.

Soil potassium content

Average soil potassium content among the treatments ranged from 140-178 (ppm)(Table 02). According to the results there is no significant difference with temperature. Significant variation was shown between coir dust and no mulch condition. The highest soil potassium content was reported from coir dust mulched treatment and lowest soil potassium content was shown from no mulch condition. Tree-based mulches influence soil potassium and plant growth. Growth and fruit yields were associated with K availability in the soil and potassium content proportionally increased with the yield.

CONCLUSION

Results showed that higher temperature stress in natural environment either due to global warming or any other conditions could be reduced by using mulches. According to this temperature simulated field study the adverse effects on soil due to high temperature stress of 32-34°C could be reduced by using mulches and maize performed well without significant yield reduction in coir dust mulch grown under stressful temperatures, by applying adequate water without water stress. This study is in progress and these results will be confirmed after conducting the research for another growing season. These three mulches could be easily available for farmers. Therefore the adverse effects on soil due to high temperature stress could be minimized by using mulch such as saw dust or coir dust and could ensure food security in Sri Lanka. Findings of this study will help the farmers in the dry zone to cope with temperature stress in the coming years due to climate change.

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PERFORMANCE ASSESSMENT OF TECHNICALLY SPECIFIED AND NON-SPECIFIED SPRINKLER IRRIGATION SYSTEMS IN RUBBER NURSERIES IN THE INTERMEDIATE ZONE OF SRI LANKA

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INTRODUCTION

The demand for natural rubber in Sri Lanka is increasing further, particularly with increasing consumption of rubber in the world. The total rubber extent of the country is about 128,100 ha while the total mature extent in the country is 101,700 ha in year 2011. National productivity level of rubber is 1,552 kg/ha in year 2011 (MPI, 2011). In the year 2006 it was forecasted that the NR production has to be increased up to 200,000 MT by the year 2016 with a continuous production increase rate of 5% annually.

Therefore there is a need for the country to increase NR production through improving genetic composition of *Hevea brasiliensis* for high yields and the area of planting rubber. However, further expansion of rubber in traditionally growing wet areas is limited largely due to urbanization and industrialization (Iqbal et al., 2010). As a solution the Government of Sri Lanka is exploring the possibility of planting rubber in non-traditional areas such as Moneragala and Ampara Districts in the Intermediate zone and some areas in the Northern Province of the country. For those planting programmes, it requires large planting material production to reach the demand with expected level.

Therefore large scale nurseries should be maintained under the government, Regional Plantation Companies (RPCs) and private sector in those intermediate and dry zones to produce required plants. Planting material production, nursery management and bud grafting demand proper planning, timing and high quality seedlings and bud wood (Senevirathne P, 2005). The Nursery period of currently recommended planting materials is about nine months. These budded plants are raised in young budding nurseries and transplanted to the fields with the onset of monsoon rains.

But low available soil moisture, high evaporation, high temperature and wind velocity are constraints in establishing good rubber nurseries. Therefore irrigation is necessary especially in the rubber nursery management in drier areas to ensure high quality plants and high productivity and sprinkler irrigation is a convenient and efficient method of supplying water to crops for producing large and steady crop yield when compared to the other micro irrigation methods (Nakandala et al. 2008).

There are two types of sprinkler irrigation systems (*i.e.* technically specified or impact and technically non-specified) now available in the country. All these types have their own advantages and disadvantages according to their system design on operational characteristics. This paper mainly discusses the irrigation system performance on their operational characteristics as the part of this study.

Materials and Methods

Young budding rubber nursery at Monaragala Sub Station of Rubber Research Institute of Sri Lanka was selected for the study. It was located in Latitudes - 06° 50' 06" N and Longitudes - 081° 18' 55" E. The annual rainfall of the district ranges from 1250 mm to 2623 mm with the average annual rainfall of 1623 mm. The ideal rain fall for growing rubber is within the range of 1650 – 3000 mm and should be uniformly distributed throughout the year. Rainfall, less than 500 mm is severely affect the growth of rubber in early stages of planting (Yogaratnam, 2001).

The midyear dry period extends from June to August in the intermediate zone areas of the Monaragala district. During this period the probability of occurrence of dry days is high. (Wijesuriya et al., 2005).

To evaluate the systems on operational characteristics, a bucket experiment was designed to test the water distribution pattern of each system at the beginning of study under nursery conditions. A 6m * 6m square was marked on the field and it was divided in to 36 squares which have 1m². The sprinkler was centralized on the 6m * 6m square and 36 buckets were placed on centrally on each square. Sprinkler was operated and water was collected in the buckets for half an hour. Collected water was measured separately by using measuring cylinder and the diameter of the bucket was measured by using a measuring tape. The area of the bucket was then calculated. A conversion factor, based on the area of the bucket, was used to convert the volume in millilitres to depth in millimetres. The same procedure was carried out to measure the uniformity of spread of four sprinklers at four corners under the field condition. Direction and velocity of wind, temperature and humidity was also recorded during the testing period. Based on the bucket experiment uniformity coefficient, pattern efficiency was calculated.

Uniformity coefficient

A measurable index of the degree of uniformity obtainable for any size of sprinkler, operating under given conditions has been adopted and is known as the Uniformity coefficient (Cu) (Michel. 1978)

$$Cu = \left(1 - \frac{\sum x}{mn}\right)$$

In which

x = Numerical deviation of individual observations from the average application rate (mm)

m = Average value of all observation (average application rate) (mm)

n = total no of observation points

Pattern efficiency

Pattern efficiency was determined by gauge records of the bucket experiment as follows.

$$\text{Pattern efficiency} = \frac{\text{Average minimum depth of catch}}{\text{Average depth of catch}} \times 100$$

$$\text{Average depth of catch} = \frac{\text{Sum of the depths water}}{\text{No of gauges}}$$

Minimum depth of catch = 25% of gauges having the least water depth

Soil Properties

Bulk density and Field Capacity were tested of potting media before commencing irrigation practices of each treatment

Soil moisture measurements

Soil moisture content was measured daily to compare the amount of water accumulate in the poly bag by each system. The available soil moisture content in 10cm and 20 cm depth of the poly bags was measured by using a *Theta probe* (Model DL 2x).

RESULTS AND DISCUSSION

Uniformity co-efficient (Cu)

Uniformity co-efficient (Cu) is a measurable index of the degree of uniformity computed the depth of water collected in a bucket experiment. Table 1 shows the average values of Cu as percentages of sprinklers operated under various conditions. Cu of single sprinkler operation of technically specified or impact sprinkler and non specified sprinkler were 29.85% and 17.32% respectively.

Table1. Uniformity co-efficient of sprinkler testing

Test	Cu %
Technical Sprinkler (Single)	29.85
Non-Technical Sprinkler (Single)	17.32
Technical Sprinkler (four sprinklers)	92.22
Non-Technical Sprinkler (four sprinklers)	89.51

Higher the uniformity of distribution of water was obtained by a single technical sprinkler operated with a revolving type sprinkler head with two nozzles and slow rotating type (Michel, 1978). Technically non specified sprinkler contains only an orifice in the sprinkler head that was not technically designed. It has broken the rain drops in to very fine drops and with high windy conditions water droplet was moved from wetting area. Therefore low Uniformity (Cu) was observed under non-technical single sprinkler.

Therefore sprinkler laterals were placed in to 100% overlap of four sprinklers between two laterals. As shown in Table 1, both technical and non-technical sprinklers have shown more than 85% of Cu that was considered to be satisfactory under 100 % overlapping condition at system installation.

Pattern efficiency

In both systems (i.e.; technical and non-technical), the average pattern efficiencies of four sprinklers were 87% and 86% respectively which was satisfactory when the crops are lying below the riser height. But if plants were raised more than the riser height, radius of throw was interfered with plant height resulted low pattern efficiency of the system.

Table 2 Pattern efficiencies of sprinkler testing

Test	Pattern efficiency (%)
Technical Sprinkler (Single)	16.2
Non-Technical Sprinkler (Single)	12.0
Technical Sprinkler (four sprinklers)	87.0
Non-Technical Sprinkler (four sprinklers)	86.0

Soil properties

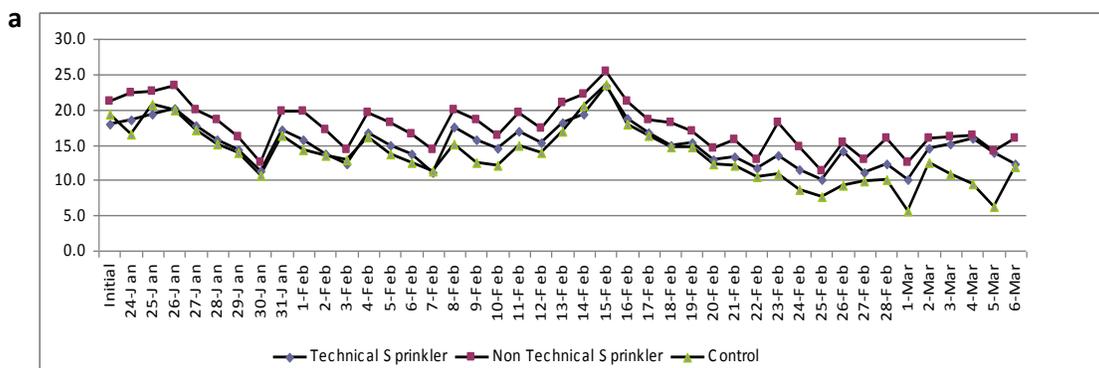
Bulk density and field capacity of the potting media of poly bag nursery was measured prior to commencement of the study. Table 3 shows the bulk densities of each soil sample take from each irrigation system. Accordingly field capacities of each potting media were varies between 21 – 25%

Table 3 Bulk density and Field capacity of potting media

Location	Bulk Density g/cm ³	FC
Technical Sprinkler (T)	1.74	22.99
Non Technical Sprinkler (N)	1.76	25.42
Control (C)	1.72	21.51

Moisture pattern

The available soil moisture content in the potting media of poly bag plants in the depths of 10 cm and 20 cm was plotted in figures 1 a and b. Moisture curves were drawn for total irrigation cycles of each irrigation system including manual watering.



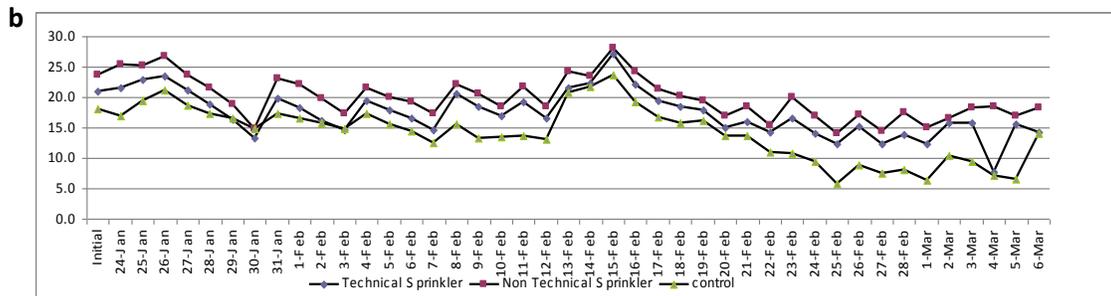


Figure 1. Moisture curves (a) – at 10 cm depth soil in poly bag plant and (b) – at 20 cm depth soil in poly bag plant

As in the figures (a) and (b), irrigation was done until field capacity was reached. Irrigation was done at the 50% depletion level was reached. Peaks in mid January and February in Figure 1 were the heavy rains occurred resulting saturated conditions in the potting media. According to the Figure 1 moisture retention in the manual watering system was comparatively low, resulting high moisture depletion level. Higher water retention was shown in non technical sprinkler irrigation system for both depths. Low discharge rate of non technical sprinkler (600 l/hr) minimize the surface runoff and maximize the infiltration rate in to the potting media of poly bag plants regardless of technical and manual watering systems.

The study was conducted to evaluate two types of sprinkler systems ie; technically specified and non-specified sprinkler systems on their operational characteristics under nursery conditions.

The operational characteristics such as uniformity co-efficient, pattern efficiency, discharge rate would directly affect the performance of the sprinkler irrigation systems. Uniformity co-efficient of technical and non-technical sprinkler systems were 92.22% and 89.51% respectively and pattern efficiencies were 87% and 86% respectively which was satisfactory for the nurseries in the intermediate zone in Sri Lanka.

Conclusion

This study highlights the operational characteristics of technically specified and non-specified sprinkler systems that directly affected the performance of the system. Maintenance of relatively high uniformity coefficient in technical irrigation system positively affected the growth of rubber nursery plants which would be important to achieve high irrigation efficiency of the system. Low discharge rate of non technical sprinkler system increases the system efficiency by minimizing the surface runoff and maximize the infiltration rate of poly bag plants which can be considered as an advantage.

Further irrigation systems are to be evaluated not only for their operational performance but also for the uniform growth of plants when selecting a proper sprinkler irrigation system.

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CONDITION ASSESSMENT AND EVALUATION OF THE NARAHENPITA RAILWAY BRIDGE

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INTRODUCTION

In Sri Lanka, railway bridges with spans less than 3 m are considered as culverts. In the very beginning, rolled I sections were not available for construction work of bridges. Hence, Rolled Steel Joists (RSJ) were used to construct culverts and bridges. The maximum available depth of these joists was 400 mm. In railway bridges of spans from 3.0 - 7.6 m, the RSJs have successfully been used. When the span is more than 7.6 m and up to 18.25 m, built up plate girders were used. In this period, rolled girders have not been produced. Hence, built - up plate girders have been used to construct main girders and other components. For these spans, depth of the girder used was around 1.6 – 2.1 m. In plate girder bridges, when the girder depth is very high, it becomes a crucial factor. For a deck type bridge, when the depth of plate girder is more, it may disturb navigation in the river. It also disturbs the water flow at flood levels. Deck type bridges are more suitable when approaches are at a higher altitude than the average flow level of the river or stream. The other factor that needs to be considered in selecting different types of structures for bridges is the wind force. Most of the bridges in the up-country are deck type bridges. To overcome the effect of the wind force, semi through or half through bridges came in to practice. Semi through bridges are designed mainly to increase the space between the bottom frame and flood level of the river and to make the river navigable. Both truss and plate girder bridges are considered as semi through bridges. When the span is more than 20 m plate girders cannot be used economically. Therefore, when the span is more than 20 m suspended or truss girder bridges have to be used by the Sri Lanka Railways (SLR).

As per the bridge register of SLR, there are 386 bridges in the railway network. Out of these, 384 bridges are steel and only 2 are concrete bridges. Among the different railway lines, the Kelani Valley (KV) line is one of the oldest tracks constructed for the Ceylon Government Railway dating back to 1902. The main objective of this track was to haul estate products to Colombo city and Fort from Kelani Valley area. Over the years after Independence in 1948, the purpose of the KV line was transformed purely to passenger transport. A majority of the passenger transportation is being done between Colombo Fort and Homagama. There are four main bridges in the KV line up to Awissawella (Hyatt 2007). The Narahenpita railway bridge is located close to the Open University of Sri Lanka (OUSL) and over the Diyawanna Oya, between Fort and Nugegoda.

At the inception of KV line, the track was designed to carry the load class H1, V2, N1, N2 and etc, (Silva 1991) which were narrow gauge locomotives having the axle loads of 8.5 to 15 imperial tons which were operated at low speeds (20-25 km/hr). About two decades back, it was proposed to convert the track from narrow gauge to broad gauge as a composite track which could operate broad gauge as well as the narrow gauge locomotives. After the removal of obsolete narrow gauge locomotives, the KV line was meant only to carry broad gauge locomotives despite the fact that the track was designed to carry narrow gauge locomotives. In 2012, Chinese built S12 Diesel Multiple Units (DMUs) were introduced in the KV line. However, S12 DMUs have 18.5 Tons axle load which are heavier than the presently operated S6 and S8 DMUs (14.5 Tons).

In the recent past, the number of passengers using the KV line has increased rapidly due to increase of the population density in Colombo suburbs from Nugegoda to Avissawella. Hence, the number of turns of travel and speed were increased to haul more passengers to meet with the

current demand. In order to achieve an acceptable solution for the above problem, the relevant authorities have proposed to develop the KV line as a dual track line and also to integrate the same with the proposed Colombo city outer circle highway. Further, there is another proposal to extend the service of the KV line up to Nonagama and interconnect to the proposed Matara Kataragama railway line.

As per the authors' knowledge, there has not been any structural assessment of the bridge. Considering all these factors, it is important to assess the present condition of the bridge to avoid any catastrophic failure of any member or a section of the bridge. Therefore, the objective of this paper is to visually assess the bridge considering present deterioration conditions and to give recommendations for further assessments.

NARAHENPITA RAILWAY BRIDGE

The existing bridge consists of two spans, which are of wrought iron; One is 32.0 m span open deck type truss bridge and the other one is 19.7 m span ballasted deck plate girder bridge shown in Figure 1. All abutments and piers are arch type brick masonry.

At the time of conversion from narrow gauge to broad gauge, a new bridge was not constructed to take the increased loads of heavier engines. Instead, temporary strengthening of the existing bridge was carried out. Due to this, restrictions on heavy engine types and speed limits were imposed as a safety precaution. At the time of conversion, no modification or strengthening was done in pier or in the abutments.

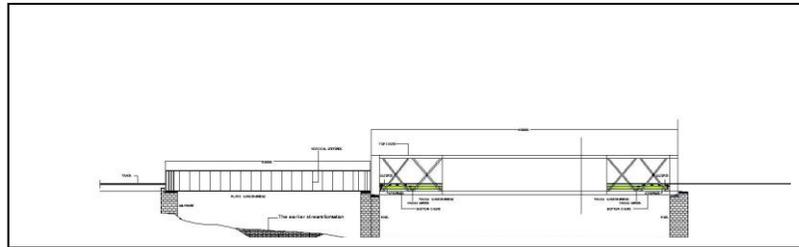


Figure 1: Schematic view of the existing bridge

METHODOLOGY

The present state of the bridge was visually evaluated to identify affected structural members and sections in the super structure and sub structure. Following sections outline the level of damage occurred in specific areas.

PLATE GIRDER BRIDGE

Physical inspection revealed that the end box of the plate girder is highly corroded and deteriorated at the Kirulapone end approach due to a high-level of corrosion. Further, the bottom chord of the girder and the steel troughs are also corroded. All the weep holes are blocked and visible sedimentation is also present. In addition, the box girder in the Narahenpita end approach is also heavily corroded. The present condition is not favorable to carry the loads of heavy engines like “M class” locomotives. Figure 2 shows the current state of the end box at the Kirulapone end.



Figure 2: View of the corroded end box
TRUSS GIRDER BRIDGE



Figure 3: View of the cross girder-bottom girder connection

The truss girder bridge is 32.0 m long Double Warren open deck type semi through bridge. At the time of conversion from narrow gauge to broad gauge, the bridge deck and top chord were strengthened to suit for the S-class loading (14.5 Tons axle load) and to maintain an average speed less than 40 km/hr. As per the visual inspection end box of Narahenpita end approach is heavily corroded and decayed. The provision of the additional stinger beam to cross girders at the strengthening stage has caused additional vibration effects to the bridge. The view of the cross girder-bottom chord connection is shown in Figure 3.

ABUTMENT AND PIER

The centre pier of the present bridge, constructed of brick masonry has distinctive cracks at the top which appear to spread towards the bottom of the pier. Therefore, it is difficult to make a proper judgment on its load carrying capacity since structural details of the bridge pier are not available with SLR. Due to the change of the stream flow path, there is an extensive scouring damage at the Narahenpita end abutment. Soaking of the abutments at the high floods may further damage the brick pier and abutment. This effect has been worsened due to the construction of a gabion wall in the river bank recently. The gabion wall has reduced the width of the water way from 50m to 30m.



Figure 4: View of the centre pier

POSSIBLE REASONS LEADING TO DETERIORATION OF THE BRIDGE

The following possible reasons were identified as the main reasons for bridge deterioration,

1. Non-responsible human behavior of the residents near the bridge.
2. Poor maintenance of the bridge. Since the weep holes provided underneath the ballasted deck are completely blocked, the storm water stagnates over the bridge. The authors are of the view that a close deck type bridge is not suitable for this place.
3. Some of the structural modifications carried out during the strengthening works of the bridge have had a detrimental effect of the bridge.

CONCLUSION

As per the visual inspection and the literature survey carried out on the Narahenpita bridge, it was revealed that no significant documentary evidence is available to make a realistic justification of the life span of the plate girder and truss bridge as well as the substructure. From the visual inspection, it was revealed that the present state of the bridge is not satisfactory. Therefore, in order to make a realistic justification of the balance service life of the bridge, a compressive condition evaluation test needs to be carried out based on the axle loads of new engines that have entered the fleet of the Sri Lanka railway. Thereby, it is possible to justify the application of new heavier DMUs.

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A STUDY OF THE EFFECT OF SUBSCRIBER CHARACTERISTICS TOWARDS THE DEMAND FOR MOBILE COMMUNICATION

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INTRODUCTION

Since its inception, wireless mobile communication has been embraced by many. The ability to roam around while being connected has been an attractive characteristic in mobile communication. Furthermore, the added features like short messaging, mobile internet and many other value added services over the mobile communication framework have been fertilizing this demand (De Silva, 2009).

Compared to other developing countries, Sri Lanka has been having a very high growth rate in its mobile communication industry. This growth has been such that by the year 2012, the number of mobile units in the country was equal to its population, resulting in a 100% penetration (TRCSL, 2013). In a Sri Lankan context, the mobile phone has been transformed from a luxury item to an essential tool, over the last 15 years.

Meanwhile, many telecommunication service providers have identified this demand for mobile communication in Sri Lanka and have entered the competition to win a portion of the subscriber base. In this process, identification of different factors affecting the telecommunication demand has been of highest importance as it helps to steer the services and coverage enhancements in the correct direction (Lee, 1988 & Valentin, 2005). Moreover, the demand affecting factors based on the subscriber characteristics are of importance. This identification would allow the service providers to design, implement and expand their mobile networks to match the subscriber requirement; and hence would win a larger portion of the subscriber base. At the same time a service provider would be able to predict the future demands and make adjustments by having a complete knowledge of the relationships (Skouby, 1991). The objective of this study is to investigate the relationship between the mobile communication demand in Sri Lanka and different considered subscriber related factors.

METHODOLOGY

This study was carried out in the urban areas of Nawala, Koswaththa, Narahenpita, Polhengoda and also in Kuliyaipitiya, Narammala, Dambadeniya, Nikaweratiya and Giriulla rural areas. A random sample of mobile subscribers was selected comprising 202 from the urban areas and 163 from the rural areas to respond to a survey questionnaire. The survey questionnaire was targeting to test the relationships between the demand for mobile communication in terms of daily usage and 11 demand dependent factors shown in Table 1. These can further be grouped into customer characteristics, customer perception, purpose of cellular network usage and social impact of mobile phones. It is important to note that most of the technology related factors which determine the demand are beyond the objective of this research, and hence not investigated.

The questionnaire consisted of 24 questions where the responses were mapped to numerical scales corresponding to different demand dependent factors. For the subscriber perception based factors, a Likert Scale (Bertram, 2013) was used for this mapping and the Likert scale was so selected that the most unfavorable response was assigned the value 0, the most favorable response

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was assigned a value **1** and the inter-response gap in the scale was constant. At the same time, responses to the other questions were also mapped to scales

between **0** and **1** with inter-response gaps in the respective scale being constants. As an example, in the mapping for the parameter “Gender”, “female” is assigned a value **0** and “male” a value **1**. Similarly in scaling the “age” parameter, age group “below 18” was assigned a value **0** and “above 50” was assigned a value **1** while other middle aged groups were assigned intermediate fractional values.

In this mapping, some parameters were addressed by more than one question, in order to have a complete coverage on the same parameter in different angles. Therefore in such instances, the responses from multiple questions were combined with unit weights to calculate a single numerical value to represent the response of each subscriber to each parameter. The daily demand/usage data of each and every subscriber was too captured via the same questionnaire.

Moreover, based on a preliminary analysis of the results, it was observed that the rural and urban mobile subscribers behave differently; hence the mapping and grading were carried out for urban and rural sectors separately. The numerical data were then analyzed with Matlab software tool to test for linear correlation between the usage and the considered factors.

RESULTS AND DISCUSSION

The correlation between the daily demand/usage and the considered eleven factors are as shown in Table 1. From Figure 1 and considering the scaling scheme used, the following can be observed.

1. There is a considerable correlation between usage and gender in urban areas while this correlation is negligible in rural areas. Furthermore, there is a tendency for the female population to have a higher mobile usage.
2. Usage greatly depends on age. In urban areas lower age groups have a high mobile usage while in rural areas it is totally the opposite.
3. Demand depends on the profession in rural areas where businessmen and self employed group dominate the usage. In urban areas, there is not much dependency on the profession as the mobile telephone is no more a luxurious or a business class item in urban areas.
4. In urban areas, the demand has a high correlation to the service requirement or the purpose of using a mobile telephone. In rural areas it is not significantly related.

Table1: Linear correlation between different factors and the mobile usage

Demand Dependent Factors	Linear Correlation Urban	Linear Correlation Rural
1.Gender	-0.22917	-0.04431
2.Age	-0.39345	0.392545
3.Profession	-0.19973	0.346147
4.Service requirement (purpose)	0.311494	0.104512
5.Quality of service expected	0.077261	-0.10268
6.Coverage expected	-0.06742	-0.00172
7.Tariff	0.037098	0.327916

8.Time of phone usage	0.096097	-0.063
9.Customer Perception	0.013357	0.307501
10.Social Beliefs	-0.07593	-0.1673
11.Promotional offers	0.236384	-0.11413

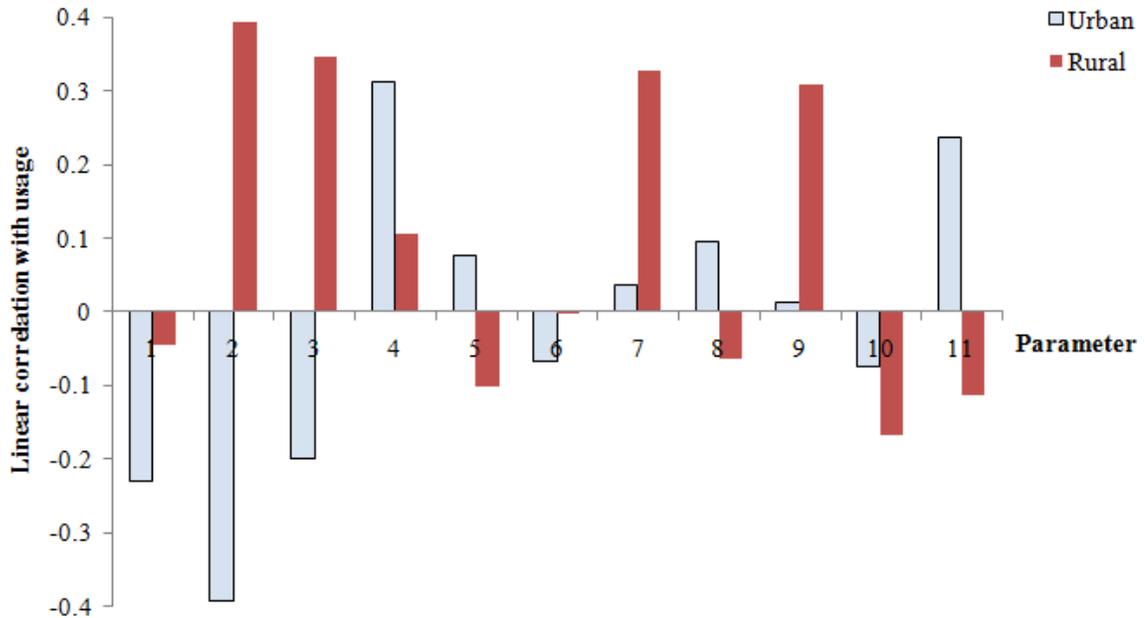


Figure 1: Comparison of correlation in urban and rural areas

- Coverage and the quality of service expected do not relate to the demand. This may be due to the fact that with the current technologies, a major part of the country is covered by all the service providers and are also maintaining very good quality standards. Therefore, subscribers are not in need of any improvements in service quality and coverage.
- Tariff seems to be not bothering the usage in urban areas while tariff is a concerned factor in rural area’s mobile usage. This behavior clearly reflects the economic standards of the urban and rural communities. Moreover, the rural community still believes that using a mobile phone is prestigious while the urban community considers it only as a useful tool.
- The rural community is more satisfied with the conventional value added services and offers while the urban community has more dynamic demands, and prefers to go for new services with smart phones.

According to the selected random sample, Mobitel is seen to be the most preferred service provider in the selected areas. Dialog and Mobitel collect almost all the subscribers in the considered urban area where as in the rural areas Airtel, Etisalat, Hutch and Dialog have 59% of the subscribers nearly equally divided between them while Mobitel leads with 41% (Figure 2). Dialog has been in the forefront of introducing new state of the art services like “e-cash” while Mobitel has been maintaining economical tariff plans like “Upahara”. This distribution can be a result of the urban subscribers’ concern over new value added services which has brought Dialog an almost equal share as Mobitel while in the rural areas Mobitel’s economical tariff plans have outperformed in the absence of the rural community’s interest towards new value added services. Not been the leaders in either the economical tariff plans or the new services, has led the other four operators to enjoy only a relatively less share.

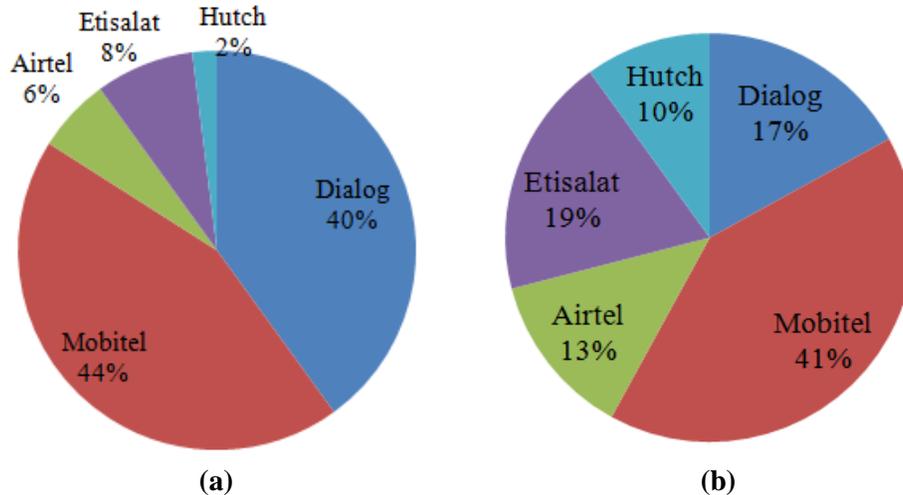


Figure 2: (a) Urban subscriber distribution (b) Rural subscriber distribution

CONCLUSIONS

Sri Lankan urban and rural mobile subscribers have different life styles and different sociological characteristics, hence different factors contribute to telecommunication demand differently. Age group, service requirement, promotional offers, gender and profession are observed as demand affecting factors in urban areas. Similarly, age group, profession, tariff and customer perception are clearly observed to be the demand affecting factors in rural areas (Figure 1).

The offering of different new services and economical tariff plans by Dialog and Mobitel respectively have earned them larger portions of the subscriber base where the subscribers value these factors. This operator preference behavior has verified the effect of different factors for rural and urban mobile communication demand.

These same results can be well utilized in upgrading the mobile communication facilities by the operators. As an example, the introduction of economic tariff plans will yield a higher usage in rural areas while the promotional offers would attract more subscribers and create more demand in urban areas.

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DEMAND PREDICTION FOR SRI LANKAN URBAN FIXED WIRELESS TELECOMMUNICATION SECTOR

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INTRODUCTION

Fixed wireless telephone systems, commonly known as the wireless local loop (WLL) systems have been a solution to many issues arising in deploying wired local loop connections. Easy deployments with high scalability together with comparatively low capital and operational costs have made fixed wireless services to be preferred over conventional wired lines. Currently, three fixed wireless operators are operating in Sri Lanka, namely Dialog, Sri Lanka Telecom (SLT) and Lankabell who rely mainly on CDMA2000 wireless system to provide voice and data services (TRCSL, 2013).

Meanwhile, in wireless communication systems, demand for communication may vary both in the short term as well as in the long term. In a conventional wireless mobile communication system, if the demand exceeds the capacity of the network segment, the new subscribers have the liberty to move to the coverage of a different segment which has free resources. However in fixed wireless systems, the movement is restricted and demands exceeding the capacity would result in blocking. This affects the service quality. On the other hand, the service providers are interested in maintaining the network resources at the minimum level, just sufficient to maintain the threshold service quality and are finding it cost ineffective to maintain the capacity always above the peak demand. Therefore, a constant alert is required to identify both the long and short term demand variations to take necessary actions to alter the capacity as required. This will allow forecasting the future demand in a particular segment both in the short and in the long term.

Telecommunication demand prediction is the activity of estimating the amount of a voice and broadband service that subscribers will utilize during a given future time. Demand forecasting involves techniques including both qualitative methods such as getting expert opinions and quantitative methods such as the analysis of historical traffic volumes (Lee, 1988 & Li, et al, 2010). In this paper a quantitative demand prediction is presented for forecasting the demand for a CDMA2000 fixed wireless system segment deployed in Sri Lankan urban areas, using time series analysis. Even though the presented results are for a short term analysis, extending the same forecasting for long term would be very similar.

METHODOLOGY

In this study, half hourly recorded past call traffic data were collected from the performance monitoring server databases of two live fixed wireless systems and was analyzed, where these two systems service more than **60%** of the total fixed wireless subscriber base in Sri Lanka. Further, a demand prediction was carried out for a network segment centered on Nawala, Koswaththa, Narahenpita, Kirimandala Mawatha, Polhengoda and Nugegoda area base stations.

Before analyzing the results, two different trends were predicted for weekdays and weekends considering the fact that the human behavior changes greatly from weekdays to weekends. Hence, the analysis was carried out for the weekdays and weekends separately. Furthermore, the traffic patterns during special holidays were observed to be very much different from those of other

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days. Even the traffic patterns during different special holidays were seen to be different from each other. Hence, to maintain the uniformity, the traffic data of special holidays were excluded from this analysis. Autoregressive Integrated Moving Average (ARIMA) model (Juan, 2008) was employed to predict future daily traffic utilization. Note that in order to utilize the ARIMA model, the data series must be stationary without any seasonality.

During this prediction process, first the autocorrelation function (ACF) and partial autocorrelation function (PACF) of the traffic data were calculated for different lags (sets of data points) to find the lag size which exhibits a stationary series behavior. Second, the prediction was carried out for the two series of data, separately. Finally, the residual plots were generated to investigate the accuracy of the prediction system.

Minitab statistical software was employed for the analysis and forecasting (Amari, 2003).

RESULTS AND DISCUSSION

Figure 1 shows the time series plots of past call traffic data. Weekdays’ and weekends’ traffic patterns clearly show different trends which justifies the prior assumption.

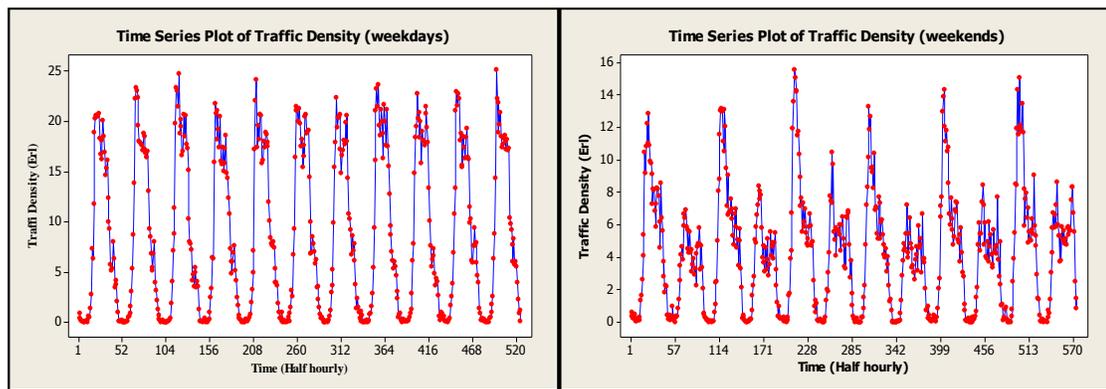


Figure 1: Time series plots for traffic density

Both series have seasonality; therefore difference was calculated to make the traffic data series to be converted to a stationary series. Using the ACF and PACF plots, the optimum lag sizes were selected to be 48 for weekdays and 96 for weekends.

The ACF and PACF of stationary data (lag size 48) for the weekday series are shown in Figure 2 where the ACF is with large spikes at initial lags and decay to zero during later lags and the PACF is with large spikes only at the first and second lags. This clearly indicates that the traffic generation process is an autoregressive moving average process with stationary behavior. The weekend series was having a similar behavior in its ACF and PACF with a lag size 96.

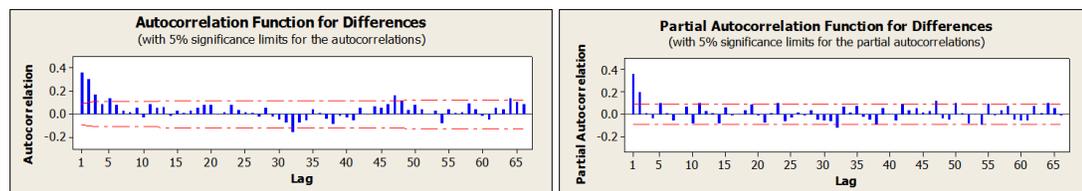


Figure 2: Auto correlation function and partial autocorrelation function

With ARIMA model, the short term prediction for the coming three days with a 95% confidence level is as shown in Figure 3 together with past eleven days’ traffic data. It is clearly visible that when the prediction duration increases the error associated is also increased.

Extracted prediction results without error bars are presented in Figure 4.

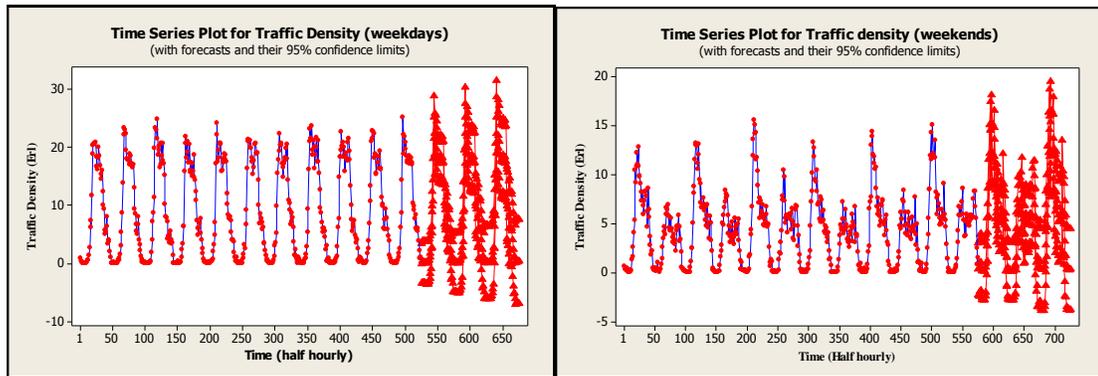


Figure 3: Time series forecasting with error margins

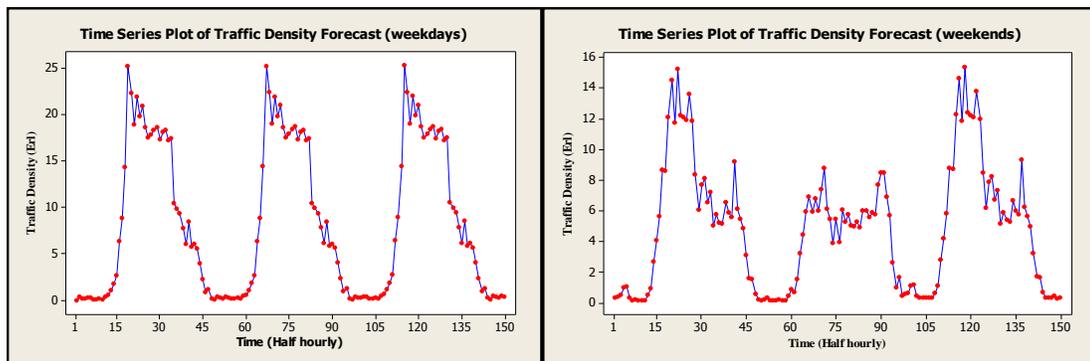


Figure 4: Time series forecasts for weekdays and weekends

According to the prediction, on weekdays 10.00am to 11.30am, the peak traffic density is to be observed which is over 20 Erlangs. Then, traffic density varies around 15-20 Erlangs between 2.30pm to 3.00pm. Traffic density changes around 5-10 Erlangs at 8.00pm during night time. Saturday traffic variation is predicted as 6-14 Erlangs while on Sunday, it is almost 6 Erlangs. Further, weekday total daily traffic utilization at an urban base station is predicted to be around 400 Erlangs while it is predicted to vary between 200 and 250 Erlangs on Saturday. On Sunday it is predicted to go down to 150 Erlangs. These predictions closely agree with the stationary pattern seen over the past, as shown in Figure 3.

Normal probability plot and histogram of residuals in Figure 5 shows a Gaussian behavior while theversus fit and order show randomly distributed residuals which verifies the accuracy of our prediction.

CONCLUSIONS/RECOMMENDATIONS

With the use of Minitab statistical software tool and based on ARIMA model, a time series prediction for a Sri Lankan urban fixed wireless sector has been presented. The results clearly demonstrate two patterns for weekdays and weekends. Moreover, the predictions have agreed very closely with the past patterns.

With the presented prediction system, while maintaining a 95% confidence level, prediction can be carried out only to predict for one third time as past time considered. However, a further prediction can be carried out with less accuracy. On the other hand, use of a larger past data set would allow prediction further in to the future maintaining the same 95% confidence level. Using forecasted demand, network planners would be able to decide how much equipment to purchase and when and where to place them to ensure optimum management of traffic loads. This

will in turn give an operator a competitive advantage in the telecommunication business while maintaining a tradeoff between the capital expenditure and the quality of service.

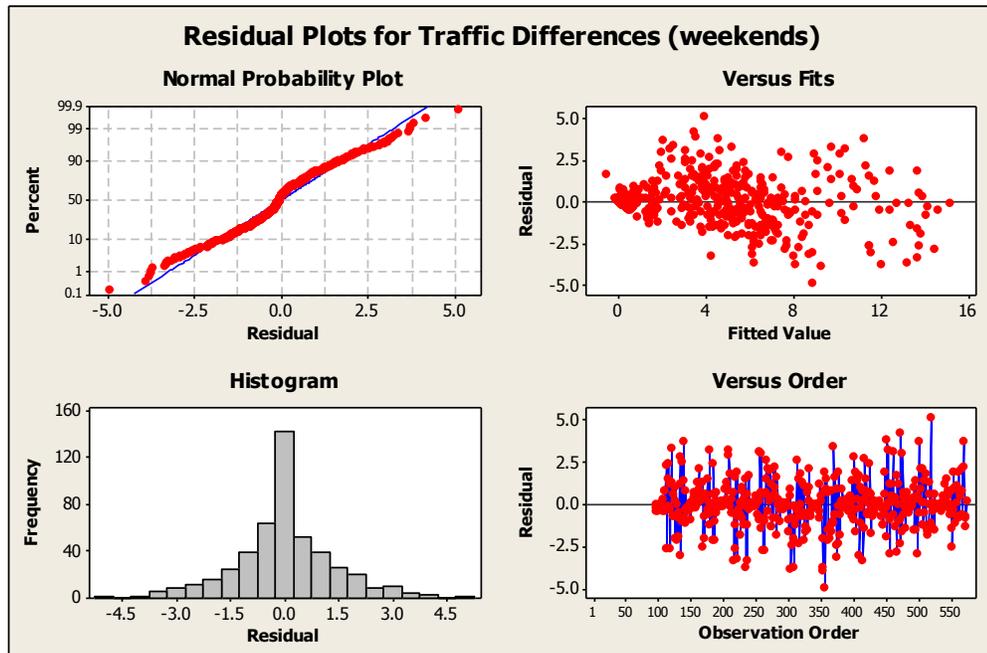


Figure 5: Residual plots for weekends

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NOTIFICATION SENDING AS CROSS CUTTING CONCERN IN ENTERPRISE APPLICATIONS

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INTRODUCTION

Technology has made vast changes in society. People use very high tech devices in their day to day life. Personal computers, mobile phones are some of them. Most software were built to use as standalone applications in earlier days. Now the situation has changed and everything functions as services which can be shared among many people. Software development focuses on building applications which are more centralized and reusable. Design architecture of software projects have become module based and different types of design concerns are used to achieve it. Modules are standalone components which can be operated independently. This approach has made many reusable components which can be reused with any other development project.

Application developed for the business domain or any other domain has mainly focused on increasing the productivity of the operations. In the same way the software development company also followed different types of methodologies, technologies and standards to increase the productivity of the software development projects. There are some aspect in the application development that are considered as the cross cutting concern which means the software concern that is external and orthogonal to the problem that a software component is designed to address. Transaction handling, security, logging, error handling, synchronization, memory allocation are some cross cutting concern in software development. We have considered that notification sending process in the application as the cross cutting concern. It is a different aspect of programming which should not interfere with the business logic. The developer should not worry about the notification sending process in the business logic. This requirement is satisfied with this project.

Most applications have a huge user base and the application interacts with users in different ways. Most business domains have a primary requirement to send various types of notifications to their users based on their activities. Identifying the various types of notifications which are common to many applications and finding the medium by which it is sent to the user and finally combining all these into one software component is the main objective of this project. There are different types of medium available today to communicate with others. Email (Electronic-mail), SMS (Short Message Service), MMS (Multimedia Message Service) and Fax are some of them. Email and SMS are the most common medium which is integrated to many applications to send messages to the end users.

Promotions, payments, offers, reminders and activities are some of the notification types commonly sent in many applications. If any application needs to send a notification mentioned previously, then the application has to facilitate such media integrations. Integration of Email or

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SMS sending can be written as a separate package and reuse it in the other classes or write it in a class which a particular operation processing is some of the way to achieve it. This approach is the result of a more specific solution which can be used within that project only because application logics are written to satisfy the scope of the business domain. If the developer wants to use it in another separate software project there could be many issues and modification to that particular coding to adapt it. Developing a more generic software module and reusing it in any software development project saves time in the development.

METHODOLOGY

We were concerned with a set of attributes before starting this project and searched whether there were any alternatives which have already been developed to cater for all these attributes. Following are those attributes: support more than one notification medium, support concurrency, support scheduling, support bulk sending, support multimedia content (images and templates) configurable with any service providers (Email and SMS service providers), deliver under open source license.

We could find out some software components which support each of this attributes separately. But none of the software components support all of these attributes at once. For example there are a number of software components which support sending email integration into the application. But none of them support concurrency, scheduling, bulk sending itself. All these attributes depend on the way that the developer will do the coding. If there are any requirements to schedule Email sending, then the developer has to think of a way to design the correct approach, develop it and test it. It may take considerable man days even a team to work on that. We focus on addressing this in our project development. We reused some of the existing software components which supported above attributes rather than developing it from scratch.

Notification API is integrated with two types of service providers. One such provider is Simple Mail Transfer Protocol (SMTP) server and the other one is SMS gateway. The developer can add configuration details of SMTP server in property file according to the client requirements. Kannel has a rich set of features which are very useful in the development process of sending SMS. The main advantage of it is that the developer can set the Kannel configuration to any mobile service providers. Currently Notification API supports one SMSC.

Notification jobs are stored in H2 memory database. Quartz scheduler runs in the same time interval and checks whether that new notification has arrived to the database. If the notification already came, then the scheduler will push the notification to the queue. Then the separate thread will handle the sending notification. This underlying mechanism was implemented with the design pattern called work stealing queue. This is the solution of IBM for the multi-threading application to handle the load of tasks and keep the application performance status higher. The notification API supports to send the Velocity email template message with embedded inline images.

Notification API is distributed as a Java Archive (jar) file. It is supported for Java based project development. Figure 1 depicts the component organization of the Notification API's notification engine. It communicated with some third party API in the run time.

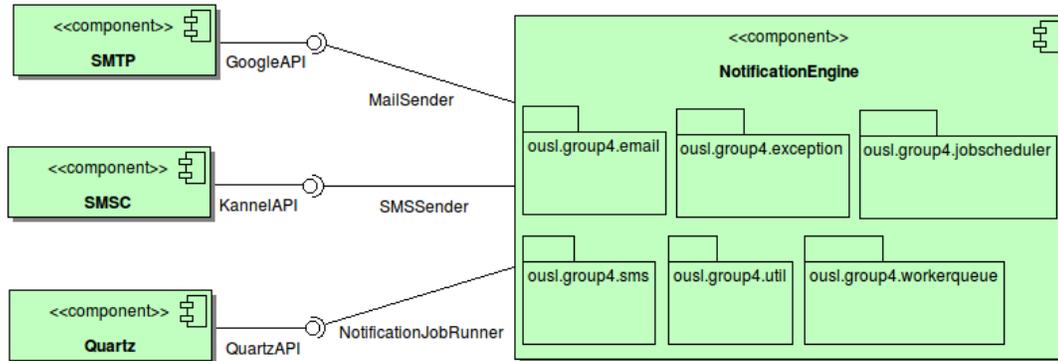


Figure 1 Component Diagram of Notification API

RESULTS AND DISCUSSION

Notification API consists of couple of methods where the developer wants to call in the coding. Rest of the operation is handled by the Notification API and it ensures that notification is sent to the recipient. There are two classes inside the library which are accessible to the outside developer after importing it to the project or after adding it as maven dependency. Notification API has two service classes (MailSender and SMSSender) which wrap all the internal services. Figure 2 and 3 depicts two methods which are more useful in notification sending in the application development.

```
/**
 * @param mailMap
 * Must contains the below key names with relevant values
 *
 * <p>
 * sender : the sender email address. cannot be null<br/>
 * recipients : the receiver(s) email addresses and send type (String[][] array
 * object). first array element: email address. second array element: pass one of
 * constant in MailSendType. cannot be null. refer: MailSendType<br/>
 * subject : the subject of email. cannot be null<br/>
 * mailBody : the body of email. cannot be null<br/>
 * attachments : Attachment(s) if necessary (Optional). must contain absolute path of
 * file(s) (String[] array object).<br/>
 * inlineImages : Inline image(s) if necessary (Optional). must contain absolute path
 * of image(s) and content id (String[][] array object).
 * </p>
 * @see ousl.group4.email.model.MailKeyBox
 * @throws ousl.group4.exception.NotificationAPIException
 */
void send(Map<String, Object> mailMap) throws NotificationAPIException;
```

Figure 2 Send method of MailSender.java

```
/**
 * @param smsMap Must contains the below key names with relevant values
 *
 * <p>
 * sender : the sender mobile. cannot be null<br/>
 * recipients : the receiver(s) mobile number (String[] array object). cannot be null.<br/>
 * smsBody : the body of sms. cannot be null</p>
 * @see ousl.group4.sms.model.SmsKeyBox
 * @throws ousl.group4.exception.NotificationAPIException
 */
void send(Map<String, Object> smsMap) throws NotificationAPIException;
```

Figure 3 Send method of SmsSender.java

Performance of the Notification API has increased by efficiently handling the concurrency. The main design concern here is to queue each and every notification sending inside the library. Work stealing queue pattern is implemented in the Notification API and it ensures that a couple of threads are dedicated to execute notification sending job. The following section specifies the nonfunctional requirements associated with the speed which the Notification API shall function. Capacity concerning the minimum number of objects the Notification API can support. The Notification API shall support a minimum of 1 email to maximum of 500 emails at each method call. The Notification API shall support a minimum of 1 SMS to maximum of 100 SMS at each method call. The system shall support a minimum of 10,000 simultaneous interactions.

Latency concerning the maximum time that is permitted for the Notification API to execute specific tasks (i.e. send email or sms). This is dependent on the bandwidth of the network. Response time concerns the maximum time that is permitted for the Notification API to respond to requests: All system responses shall occur within 30 seconds. Throughput concerning how many executions of a given Notification API operation or use case path must the system is able to execute in a unit of time: To Be Determined.

CONCLUSIONS/RECOMMENDATIONS

Notification API has been developed to customize with any changes and further any developer will be able to download the source and customize as it needs. It has already been implemented in two types of notifications medium which is email and SMS. Anyone is welcome to attach any enhancement with this API and used for their project developments.

NotificationJobRunner is responsible to notification scheduling and it is run as background process. It is highly recommended to define these classes as bean if the project uses spring framework. Figure 4 showed example bean configuration setting in the spring bean context file.

```
<!-- Notification API integration -->
<bean name="notificationJobRunner" class="ousl.group4.jobscheduler.NotificationJobRunner"
    lazy-init="false" init-method="initSendNotifications"/>
<bean name="mailSender" class="ousl.group4.email.service.impl.MailSenderImpl"/>
<bean name="smsSender" class="ousl.group4.sms.service.impl.SmsSenderImpl"/>
```

Figure 4 Define Notification API service classes as spring beans

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UTILIZATION OF MOBILE TECHNOLOGY AND SECURITY ALGORITHMS TO PREVENT FORGERY OF NATIONAL IDENTITY CARDS OF THE CITIZENS OF SRI LANKA - A CONCEPT PAPER

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INTRODUCTION

The National Identity Card (NIC) of a citizen of Sri Lanka is a handwritten paper with a lamination. The latest initiative is to issue smart ID by year 2016. Due to infrastructure and structural changes and associated cost, previous plans have still not come to fruition. Currently the same old mechanism is in use and several scams producing illegal NICs have been discovered.

A tedious document validation mechanism exists when obtaining a legal NIC, but forging it is an easy task. The photo could be swapped, and there is no quick verification mechanism for current NIC by a law enforcement authority when it is produced for verification. Any fraudulent person who has access to printed material can produce a NIC which can go unnoticed.

The aim of this paper is to present a low cost mechanism to prevent forgery of NICs devised from existing security and mobile technologies. The proposed mechanism would make a minimum change to existing NIC and its production mechanism. It makes an NIC authenticable over a mobile phone, prevents changing of data at the Department of Registrations of Persons (DRP), Department of Defense (DoD) and prevents fraudulent persons taking advantage of the NIC verification system as well.

METHODOLOGY

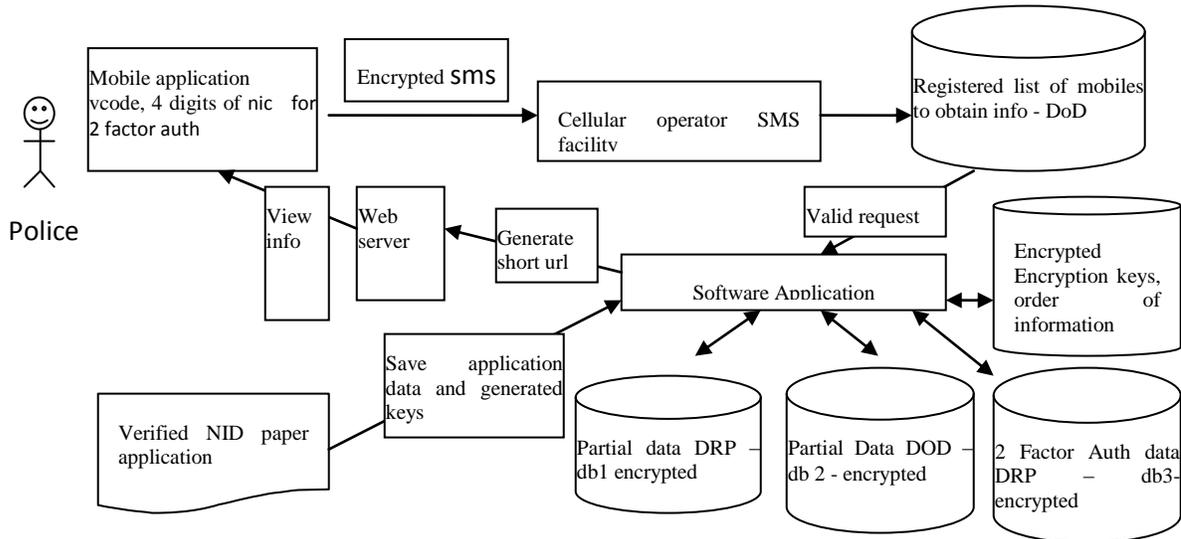
The author proposes to print a code (Vcode) with five alpha numeric characters in several locations of a NIC to prevent defacing or smudges if printed in a single place. Vcode comprises a combination of a-z, A-Z, 1-9 excluding letters l,o,O (59 different characters). Approximately 714 million (59^5) different combinations exist for a five character Vcode which exceeds requirement of a little over 20 million population for Sri Lanka. A QR code (ISO/IEC 18004 June 2000) could be printed for easy reading by a mobile phone without typing the code in. The five digit code is used to make the NIC verifiable. Mechanism to setup the verification process is a onetime task.

Any information pertaining to the citizen could be kept such as finger print information, blood type and retina scan information as done in the ID card scheme in India which could be encrypted by a public key of the Department of Registration of persons then stored in database. The author proposes having two different databases, one in Dept of Registration of Persons and other in Department of Defense (DoD) to prevent IT aware people from tampering with the data.

Information fields contained in an NIC has to be ordered as a single string. Eg. Full name, other names, birthday, birth location, occupation and the address, issue date, national ID number, CRC hash code of the photo generated from a hashing algorithm CRC32 (Williams 1993) and a time stamp to prevent unauthorized updates. The entire string has to be again encrypted by an algorithm like blowfish (Schneier 1993) with appropriate key. Author recommends using blowfish / two fish algorithms because this algorithm has not broken yet and the implementation

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is open. Half of this encrypted personal information string (EPS) has to be stored in the Department of Registration of Persons and the other half has to be stored in a database of Department of Defense (DoD) so that either party cannot make any unauthorized alterations.



Vcode is generated using the characters generated by CRC hashing (Boyd 2012) along with digits in NIC number. If duplicate vcode is generated then padding is introduced to the original information string and regenerates EPS and Vcode. The ordering of the data fields change randomly (by a software application) from person to person but the order of which information is lined up is also kept in a separate database along with the key used for encryption. This information has to be again encrypted by blowfish algorithm with a key larger than 12 characters. The four consecutive digits of NIC number has to be kept separately hashed by a latest SHA algorithm (for the purposes of two step verification (eg. For 885432234v hash codes of 885432234v, 8854, 8543, 5432, 4322, 3223, 2234 has to be stored with 5 character verification code). This entire process is driven by a software and it could be done only once per application. Any update should be prohibited. To remove a record proper statutory procedure involving at least two designated officers and one random officer picked by the software is proposed. To access the system access card of the employee, pin and a remote approval from Officer in charge for the day is required.

Stored in Department of registration of persons in two distinct databases

5 character vcode	1 st Half of EPS	CRC of EPS	CRC of Photo	Hash of NIC
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5 character vcode	Encrypted encrypt key of EPS	Encrypted order of fields	photo
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Key used to encrypt the key used for EPS has to be strictly protected, possibly keys should be generated from the local language to prevent foreigners using dictionary attacks. Following fields are required for 2 step verification

5 character verification code	Hash of NIC	Hash of 1 st 4 digits	Hash of 2 nd 4 digits	Hash of 3 rd 4 digits	Hash of 4 th 4 digits	Hash of 5 th 4 digits	Hash of 6 th 4 digits
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Stored in Department of defense (db 2)

5 character v code	2 nd Half of EPS	CRC of EPS	CRC of Photo	Hash of NIC
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In addition database of people who are authorized to verify the NICs has to be maintained at

Department of Defense or at any other secure location.

When the person presents their NIC to a law enforcement officer, he should use a software installed in his phone to verify it by entering vcode printed in a NIC along with 4 consecutive digits of NIC number. These 4 digits were again randomly asked to prevent misusing the facility as well as typing mistakes of vcode.

Five character verification code and the 4 consecutive digits of NIC is then encrypted by blowfish with pin of requester as the key. It will be sent to a requester verification server which verifies the authenticity of the requestor from its database of registered mobile number, pin and phone IMEI number. Then the server will contact the Department of Registration of persons database via a secure link to obtain information using the 5 digit verification code and hash of 4 digits of the NIC number. It will generate a temporary url or MMS to the requester providing the verification information. The officer can verify the ID by comparing details received by him with the NIC at hand.

RESULTS AND DISCUSSION

Analyzing and choosing the right combination of strong security algorithms / technologies which are not commercially bound to any country or a company which are stated in this paper was the work carried out by the author. The idea is given as the concept paper and it is open for discussion for possible flaws. Several scenarios presented under results and discussion where this mechanism would prevent illegal activities even by parties who manage this system.

Table 1 – How this approach solves different problems associated with current NICs

Problem	How the proposed approach address the issue
Verification of NIC	This approach solves the problem. Any government entity or road side police officer can verify NIC using a average mobile phone No need to provide official mobile phones existing mobile of the officer would be sufficient.
Police officer enters arbitrary vcode	With 2 step authentication officer has to enter 4 digits of actual NIC number. Therefore misuses could be avoided.
Verification officer's mobile device is stolen	With officer's pin system is secured. Using the sim in different phone will not work because the system requires registered phone.
Attempts to change the photo by NIC holder or any personal detail by an employee of department of registration of persons	System sends the actual photo via MMS or accessed via short URL. User cannot affix a new photograph. Staffer cannot change the photo because CRC is generated with the timestamp of saving the entire record. Personal information string is encrypted. Changing it without using the system will be difficult without the key used for encryption. Deleting the entire record will require authorization of 3 people. 2 designated and 1 random. If it is physically deleted from database server and re entered then the time stamps will reveal the activity.
Unauthorized access to software system.	This could be prevented using two step access mechanism. That is to use the system it requires password and access card of an employee and the approval of the officer in charge for the day. So working in non office hrs could be easily prevented.
Attempts of mobile operators to obtain the information as a bulk	This is prevented because of the law enforcement officer pin number and the information sent via SMS is encrypted using officer pin and decrypted at department of defense.

Multilingual facility and user friendliness	Proposed mechanism is a generalized version that supports all three language NICs if hand written as per government directive recently. Only data entry required in at least 2 languages. The user application in mobile could be developed to support all 3 languages and the encryption algorithms do not distinguish between languages.
Migrate existing NIC holders to new system	That would require entering their data to the system and print the verification code and QR code into their NICs.
Cost effectiveness and ease of use	Existing application procedure will be kept intact. Only data entry fee and vcode printing fee is required to be charged. The approach does require a short toll free phone number from a mobile operator. IT infrastructure management cost and the cost for Public/Private keys. But the cost required (SMS/Internet cost) for verification is lot less compared to digital chip card readers. Fraudulent activities of coping digital cards also could be prevented as system always rely on a central database. Sri Lanka has good cellular operator coverage. Use of well established mobile operator will reduce infrastructure cost.

CONCLUSIONS/RECOMMENDATIONS

Information presented in this paper is a group of mechanisms to prevent frauds in existing NIC scheme of Sri Lankan Citizens. Implementation is completely feasible as the selected technologies / algorithms presented in this paper are regularly used in different application domains. A prototype software application to implement the concept will require 2 mobile phones (police officer / SMS gateway), Open Source SMS gateway, Tomcat/ Apache web server, Java / PHP development environment if Linux Operating system is used or Visual Studio development environment for a windows application at DRP/DoD.

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DEVELOPMENT OF MODIFIED CONCRETE INTERLOCKING BLOCKS FOR PAVEMENT CONSTRUCTION IN SRI LANKA.

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INTRODUCTION

Concrete interlocking block (CIB) pavements were introduced to Sri Lanka in late 2000 and the use of CIB has increased remarkably after that. The construction pattern in concrete interlocking block pavement is an important factor, as maintenance cost can be controlled by the counteraction pattern. The herringbone laying pattern is the most effective arrangement for the carrying traffic (Soutsos, 2011). For herringbone laying pattern, the direction of the traffic relative to the alignment of the pattern has little effect on pavement performance (Korean Industrial Standards Committee, 1995, Gonzalo,1990)

Though concrete interlocking blocks provide many advantages both during the construction and during the functional stage it has been noticed that some of interlocking blocks get damaged due to poor tensile capacity (Karunaratna, 2012). This is one of the major disadvantages of the interlocking block pavements. This problem can be avoided by upgrading the tensile strength of the blocks. The improvement of the tensile strength can be carried out in many ways (Neville, 1999, Shetty, 2010). One simplest approach is improving the compressive strength and the other approach is by the addition of steel fiber types material to the concrete mix. In this study, we try to upgrade the tensile property of concrete interlocking blocks by altering the traditional mix with steel fiber type materials.

METHODOLOGY

PRODUCTION OF MODIFIED INTERLOCKING BLOCKS

Our work can be divided into two parts. The first part was aimed at the determination of the effects of modified mixtures, with less cement content (Non-reinforced interlocking blocks). The second part was aimed to evaluate the influence of binding wires on the properties of the CIBs. The mixture is selected here with randomly oriented small binding wires.

Non-reinforced interlocking blocks

Two different cement contents 300 kg/m³ and 350 kg/m³ were selected based on the practices in the other countries (Gencel, 2012, Uygunoglu2012). The rest of the material was determined using the standard mix design method. These mixtures are named A and B. The Water cement ratio (W/C) of each mix was changed approximately from 0.34 to 0.6 for the study of compressive strength and tensile strengths. Mix proportions are summarized in Table 1.

i. Reinforced interlocking concrete blocks

Reinforced interlocking concrete blocks were produced by using small binding wires in random orientation (mix D). In preparing these samples the small binding wire pieces were mixed with the normal concrete mix in the mould. The samples were cured for 7 days as in the sites.

The comparison of mix D against steel fiber reinforced concrete and the mix proportion of mix D are tabulated in Table 2. The properties of steel fiber reinforced concrete was obtained from Xu, 2009.

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Table 1 – Mix proportion for mix A and mix B with water cement ratios

W/C	Material							
	Mix A				Mix B			
	OPC (kg/m ³)	Water content (kg/m ³)	Fine aggregate (kg/m ³)	Coarse aggregate (kg/m ³)	OPC (kg/m ³)	Water content (kg/m ³)	Fine aggregate (kg/m ³)	Coarse aggregate (kg/m ³)
0.34	300	102	1224.40	1249.13				
0.35					350	122.50	971.06	1002.84
0.38	300	114	1022.00	1022.00				
0.40					350	140.00	976.37	957.03
0.42	300	126	1026.12	985.88				
0.425					350	148.75	977.10	938.76
0.45	300	135	1028.63	968.72	350	157.50	976.00	919.13
0.475					350	166.25	975.00	900.07
0.50	300	150	1014.23	917.64	350	175.00	974.85	882.02
0.55					350	192.50	975.07	840.71
0.60					350	210.00	975.33	801.26

*OPC-Ordinary Portland Cement

Table 2 - Comparison of Database information of the mechanical properties for Steel fiber reinforced concrete and reinforced mixes

	Steel Fiber Reinforced Concrete	Mix D
W/C Ratio	0.25-0.50	0.50
Fraction %	0.50-1.50	0.40
Aspect Ratio	50-80	50
Cement Content (Kg/m ³)	320 (minimum)	350
Sand Content (Kg/m ³)	750-850 (reasonable)	974.85
Aggregate Size (mm)	19 (maximum)	≤ 10

RESULTS AND DISCUSSION

Figure 1 presents the variation of compressive strength against the water cement ratio for mix A and B. The results of mix A show that the optimum W/C ratio has not been achieved as the strength is still increasing against the W/C ratio. In the mix B, it can be observed from our results that the compressive strength increases up to W/C ratio 0.5. Therefore the optimum W/C ratio can be determined as 0.5. The relationship between the W/C and strength is well established (Neville, 1999, Shetty, 2010). We believe that the strength gain is due the difference in W/C.

We prepare samples with binding wires with the optimum water cement ratio of 0.50. Comparisons of compressive strength of different mixtures are presented in Figure 2a. All mixtures show higher strength development.

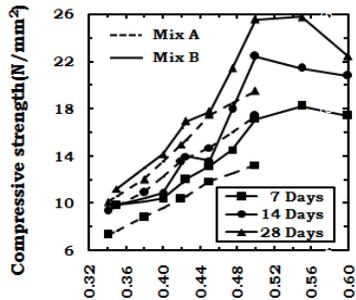


Fig.1-Variation of Avg compressive strength for Mix A and B.

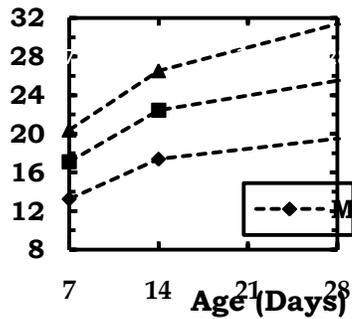


Fig.2a-Comparison of compressive of different mixtures

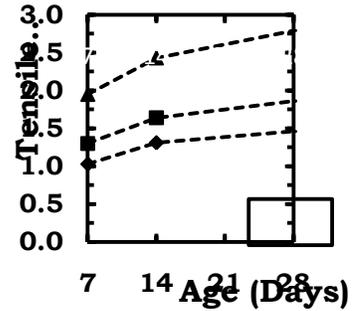


Fig.2b. Comparison of tensile strengths of different mixtures

However the arbitrary oriented binding wires sample has significantly improved the compressive strength. This is probably due to the control of micro cracks that are taking place inside the samples during the compression test. Several numerical softwares are available today to produce such micro cracks using synthetic material in numerical simulation (Potyondy, 2009). It can be reasonably assumed that these small binding wires control the growth of micro cracks during the experiment. When small pieces of binding wires are randomly placed in the mix, the growth of micro cracks are controlled by bonded binding wires. Hence significant improvement of strength can be observed.

The tensile strength of mix A and B can be determined directly from the SANS 1058:2009 (Cairns, 2009) as they are unreinforced. Analysis of the material quantities of mix D shows that it can be considered as a polymer concrete. Therefore the results provided by (Xu, 2009) are exploited in the present study to determine the tensile strength of mix D. The tensile strength of different mixtures are given in Figure 2b. Samples of mix D show higher tensile strength gain. This agrees with the improvement of compressive strength in different mixtures.

Although, one might think that this mix with binding wires is more expensive than that of the traditional mixtures, it can be explicitly illustrated that the modified mixtures are in fact cheaper than the traditional mixtures (Karunaratna, 2012). Use of the modified mix provides 4% cost saving for 1000 bricks even if we use higher labour cost for the modified blocks. Cost values were determined based on the market values of the material cost in 2011, February. This may vary according the present values.

CONCLUSIONS

We have modified the existing mix proportions used for the production of concrete interlocking blocks. Binding wires are used to upgrade tensile strength of the interlocking concrete blocks. The compressive strength of each mix was determined at 7, 14 and 28 days. The tensile strength of non reinforced mix was determined by incorporating Cairns approach (Cairns, 2009) where as the tensile strength of reinforced mixtures was determined using tensile strength of polymer concrete. The resulting values show greater improvement in the tensile strength. Our methodology therefore offers a promising and simple approach to enhance the tensile strength of concrete interlocking blocks. The increment of tensile strength in the modified CIBs is about 50%. Use of the modified mix provides 4% cost saving for 1000 bricks of modified blocks

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USE OF FLY ASH IN HOT MIX ASPHALT CONCRETE

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INTRODUCTION

In Sri Lanka, quarry dust is generally used as the mineral filler in hot mixed asphalt concrete. Quarry dust is a byproduct in rock quarries. Fly ash is found in Norochcholai coal power plant as an industrial waste. This paper presents the results of an investigation into the feasibility of using fly ash as a partial substitute for mineral filler in hot mixed asphalt concrete. The results of this study will help reduce the consumption of depleting resources as rock and minimize environmental hazards that occur through disposal of fly ash.

Nearly all main highways and pavements in Sri Lanka are constructed using asphalt pavements which consist of coarse aggregate, fine aggregate, mineral filler and a bituminous binder. The coarse aggregate is crushed stone with particle size ranging from 2.36mm to 19mm. The fine aggregate is sand or quarry dust, in which the size ranges between 0.15mm and 2.36mm. The mineral filler normally used is a quarry dust, 85 percent of which passes the 0.075mm sieve. The aggregate mixture is bound together with bitumen. To replace quarry dust with fly ash firstly, it is required to examine the physical properties, to check samples for conformity. Secondly, the Marshall Test method, which is a widely used test recommended by Asphalt institute and presently used by Road Development Authority of Sri Lanka, is adopted for optimizing the proportioning of the asphaltic concrete mix components and the Marshall properties of the samples are checked for conformity. Marshall Test method on three sets of tests were conducted by replacing mineral filler with fly ash in the percentages of 100%, 58% 42% (12%, 7% and 5% respectively from the total weight of aggregates). The ICTAD specifications were fulfilled only for the replacement of 42% of mineral filler with fly ash (5% from total weight of aggregates).

METHODOLOGY

Sieve analysis was carried out according to ASTM D 3515, on a representative sample of the fly ash. For the determination of specific gravity and fineness of fly ash and quarry dust ASTM D 854 and ASTM C 204 were used respectively. The results of above tests are given in Tables 1, 2 and 3.

Marshall test method was carried out as follows. A filler content consisting of 12% of quarry dust and fly ash combined (5% of fly ash and 7% of quarry dust) was added to 57.5% and 30.5% of coarse and fine aggregates, respectively (Asphalt Institute, 1997). These aggregate proportions are typical of wearing course mixes normally used for main roads in Sri Lanka. Standard Marshall Specimens (63.5 mm height and 101.6 mm diameter) were prepared in the following manner. Weight of bitumen was varied from 3.5% to 6% in steps of 0.5%, resulting in six percentages by weight of bitumen content, and three samples were prepared for each bitumen percentage. The grading and proportions were kept constant for all the mixes by sieving the aggregates to individual sizes and then recombining them in a continuous grading required by the local standards.

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The same quantity of materials was used for each sample in an effort to obtain approximately the same height of the specimens. The mix was first partially compacted using a heated standard rod, fifteen times around the perimeter and five times in the center. The whole mould was then fixed in the Marshall Compaction machine which consists of a 4.5 kg hammer falling from a distance of 457 mm. Both sides of the samples were compacted 75 times. The compacted samples were allowed to cure overnight at room temperature. The density of the samples was then determined by obtaining the submerged weight in water and weighing the samples in air. Samples were then tested at standard temperature (60 °C) in the Marshall machine and the deformation stability (in kN) and the flow of the samples (in mm) were recorded. The same procedure was repeated for all samples.

RESULTS AND DISCUSSION

In test results of the Tables 1, 2 and 3 represents the particle size analysis, specific gravity and fineness of fly ash respectively.

Table 1- Sieve analysis test results for fly ash

Sieve size	Weight retained / (g)	Total weight retained / (g)	% retained	% Passing
2.36 mm	0.64	0.64	0.062	99.938
1.18 mm	4.13	4.77	0.461	99.539
600 µm	10.84	15.61	1.508	98.492
300 µm	25.48	41.09	3.970	96.030
150 µm	414.57	455.66	44.027	55.973
75 µm	363.80	819.46	79.179	20.821
Pan	204.66	1024.12	98.954	1.046

Table 2- Specific gravity of fly ash and quarry dust

Sample No.	Specific gravity	
	Fly ash	Quarry dust
01	2.068	2.429
02	2.044	2.330
03	2.077	2.500
Average	2.063	2.420

Table 3- Specific surface (fineness) of fly ash and quarry dust

Trial	Specific surface	
	Fly ash x <i>K</i>	Quarry dust x <i>K</i>
01	0.463	0.404
02	0.426	0.416
03	0.474	0.442
Average	0.454	0.421

Figures 1 - 5 illustrates the Marshall properties of the samples. These include the crushing strength or stability, the deformation behavior or flow, as well as the density and voids

characteristics of the asphaltic mixes. It is observed that a bitumen content of 5.5% satisfies the Institute of Construction Training and Development (ICTAD) specifications. Figure 1 represents the maximum stability values of the mixes. For bitumen content of 5.5% the stability value was observed to be 8.6 kN. This value was in conformity with the ICTAD specifications. Figure 2 shows the effect of variation of the bitumen content on the Marshall Flow expressed in millimeters. For the 5.5% bitumen content it can be seen that the mix had the required flow value of 14.41. Figure 3 indicates that the percentage of air voids in the mix decreases as the bitumen content increases. This is expected since the bitumen will fill the voids in aggregate matrix. However, there is a limit on how much the voids can be reduced. If they are too high then deformation and loss of stability is expected in the field, and if they are too low then bleeding and shoving due to expansion occurs because of high temperatures. For a bitumen content of 5.5%, voids in mix lie in the range specified, which 3% to 7% is. Figure 4 shows that the minimum voids in the mineral aggregates are greater than 13%. Figure 5 indicates that for bitumen content of 5.5% the voids filled with bitumen is in the range of 70-85% which is the specified range. Figure 6 indicates the compacted density mix values which are required for calculation of voids

Table 4 summarizes the Marshall properties of the mix determined at an optimum bitumen content of 5.5%, compared with the ICTAD specifications.

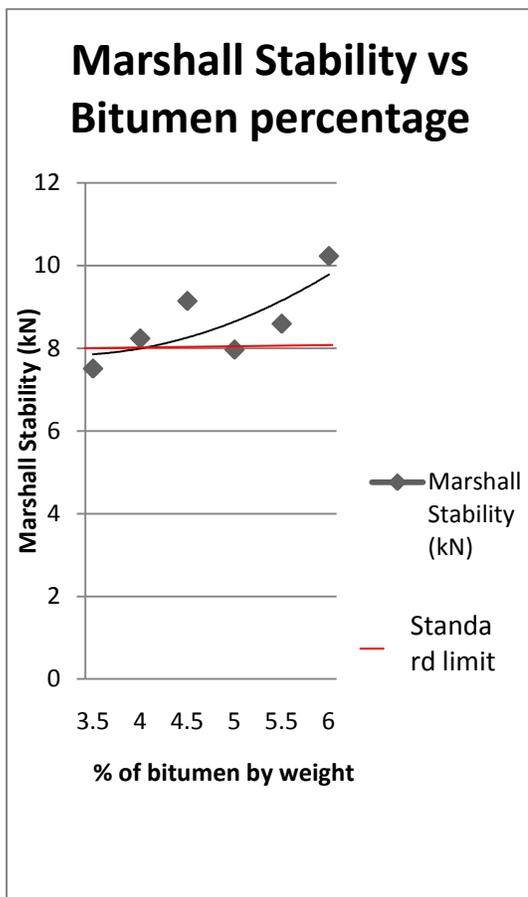


Figure 1 Effect of fly ash on the Marshall stability of Asphaltic concrete

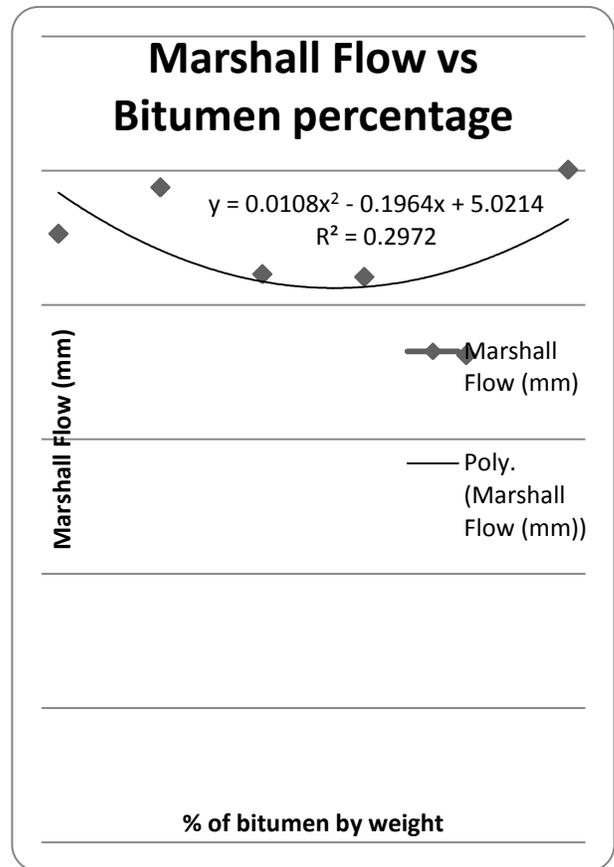


Figure 2 Effect of fly ash on the Marshall flow of asphaltic concrete

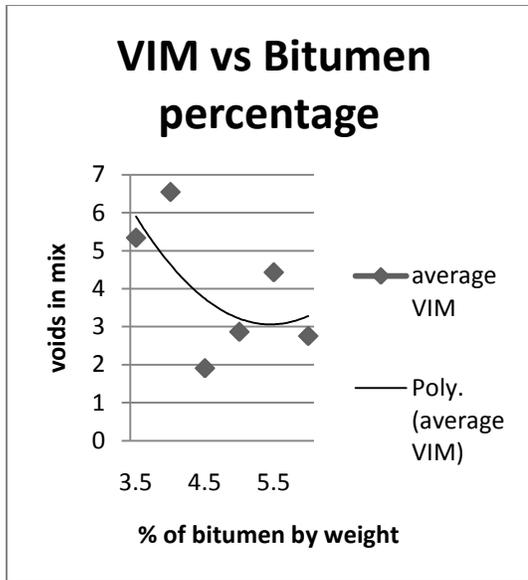


Figure 3 Effect of fly ash on voids of asphaltic concrete

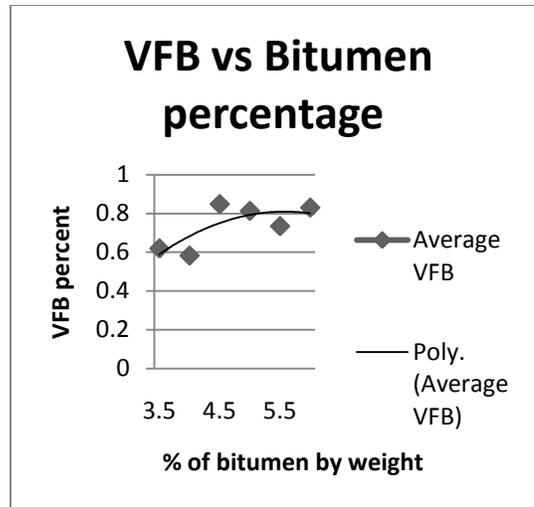


Figure 5 Effect of fly ash on voids filled with bitumen of asphaltic concrete

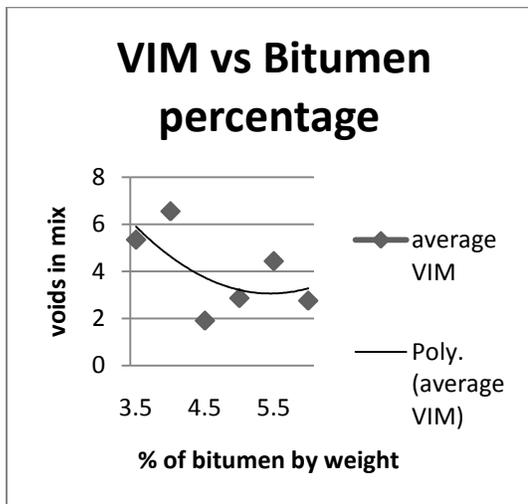


Figure 4 Effect of fly ash on voids in aggregate of asphaltic concrete

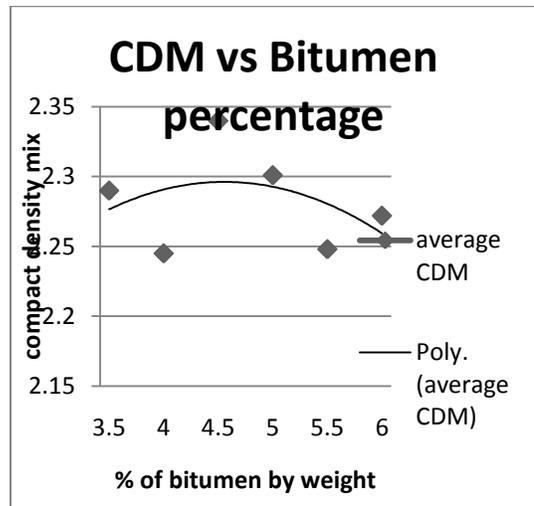


Figure 6 Effect of fly ash on the compacted density of asphaltic concrete

Table 4 Marshall Properties of asphaltic mix at bitumen content of 5.5% compared with ICTAD specifications

Marshall parameter	Value at 5.5% bitumen content	ICTAD Specification limit
Marshall Stability in kN	8.6	Not less than 8
Marshall Flow in(0.25 mm)	14.51	8 to 16
Air voids in Mix (%)	4.44	3 to 7
Voids in Mineral Aggregates (%)	16.56	Not less than 13
Voids Filled with bitumen (%)	73.4	70 to 85

CONCLUSIONS

From the results and preceding discussion, the following can be concluded:

- Results conforming to specifications were obtained by replacing 5% of mineral filler from the total weight of aggregates with Fly ash.
- The stability value of replacing 5% of mineral filler from total weight of aggregates with fly ash was well above the minimum (8 kN) criteria in ICTAD specification.
- The optimum bitumen content by weight of the aggregates was 5.5% which satisfied the ICTAD specifications.
- The fly ash can be utilized as a partial replacement for the mineral filler in hot mix asphalt concrete wearing courses used in Sri Lanka.

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EFFECTIVENESS OF AN INDUCTION PROGRAMME IN INSPIRING STUDENTS IN ENGAGING IN COLLABORATIVE LEARNING: AN ODL CASE STUDY

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INTRODUCTION

Student engagement is a key factor in determining the academic success of any student¹. Hence, academic institutions must search for interventions for improving student engagement in increasing retention and completion rates of their programmes. This is especially true in Open and Distance Learning (ODL) where the completion rates are intrinsically low.

Motivation and competency of students, students' transactions with teachers and peers, institutional support received by students, realization of students' social beliefs and practices and support by family and friends are identified as key factors that positively influence student engagement¹. As such, any intervention designed to improve student engagement should address these issues. To have the maximum benefit, from an institutional point of view, it is desirable to administer such an intervention when the probability of student disengagement is at a maximum level.

Transition from a teacher dependent school learning environment to a more independent university environment is a stressful phase for most young students^{2,3}. For mature students, who start a student career after a period of discontinuity, this can be an even more stressful experience. As such, the probability of disengagement is high during the first year in a University². Hence, increasingly, interventions for improving student engagement are administered during the first year in University.

One such intervention constitutes the facilitation of establishing learning communities⁴. A learning community may be considered as a group of students who work together in achieving academic as well as social goals. A learning community differs from any other community of students due to the fact that its members exert substantial effort in achieving academic goals. Creating learning communities could address all the factors conducive for improving student engagement mentioned above. Formation of such communities may be achieved using collaborative learning (CL) as the basis. Hence, one may expect that if the students are sufficiently inspired in engaging in CL then they will voluntarily form their own learning communities.

In moving towards this goal, the Faculty of Natural Sciences introduced a one-day induction programme for the new entrants to the BSc programme in the academic year 2012/2013. It was designed for the students to realize the positive aspects of CL and thereby inspire them in engaging in it. The objective of this study is to examine the effectiveness of the induction programme in inspiring students for engaging in CL.

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METHODOLOGY

The one-day induction was conducted at the Colombo Regional Centre of the Open University of Sri Lanka (OUSL) and was opened to all the new entrants to the BSc programme in the academic year 2012/2013. Induction was repeated on two more days in giving flexibility in time to the students. The students were grouped with each group having 10 – 15 members. To foster long term relationships, the grouping was based on the most preferred subject discipline as chosen by the students.

The major activities of the induction commenced with a one and a half hour seminar presentation by a staff member on the power of mind, leadership, teamwork, environment, aesthetics, concentration and motivation. This was aimed at energizing and motivating students for active participation in the induction. Thereafter, a half an hour group activity in self-naming and self-selection of a theme by each group was conducted in allowing members to know each other socially. One hour was then devoted for a presentation of the strategies they used in succeeding at OUSL by three OUSL graduates of good academic standing. It was presented as a combined narrative and a discussion of their experience in making the listeners motivated.

The CL activity involving scientific discourse took about one and a half hours. It involved a presentation of a natural phenomenon and its scientific explanation by a staff member. Then the students were shown a video clip of a seemingly different phenomenon, enacted by some students as an amusing event, which could be explained using the principles described by the staff member earlier. A video clip, without narration, was then screened in giving some clues which may be of help to the students in developing an explanation. The students were then asked to develop a scientific explanation of the phenomenon through group discussion.

Student perception on various aspects of CL was obtained on 4 and 5 point Likert scales, from all the participants, both before and after the induction, using two separate questionnaires. Some of the statements where the student perception was sought were the same in both questionnaires which enabled us to determine the change in student perception brought about by the Induction. The questionnaires were made bilingual, either Sinhala/English or Tamil/English, in improving the reliability of data. Perception data collected before and after the Induction was extracted and analysed using standard statistical methods in order to examine the effectiveness of Induction in inspiring students for CL.

RESULTS AND DISCUSSION

The total numbers of participants at the beginning and at the end of Induction were 242 and 216, respectively. The reduction (about 10%) in population is due to the fact that some students left before the induction was over.

Tables 1a and 1b summarise the characteristics of the populations used in collecting perception data. (Percentages do not add up to 100 in some categories since some students did not provide the relevant information.).

Table 1a: Characteristics of the populations used in the study.

Timing in Induction	Population size	Gender		Employment status		Marital status	
		Male	Female	Yes	No	Yes	No
Before	242	31%	69%	45%	54%	6%	94%
After	216	31%	66%	46%	48%	5%	92%

Table 1b: Characteristics of the populations used in the study.

Timing in Induction	Population size	Age (Years)			
		< 20	20 – 25	25 – 30	> 30
Before	242	1.7%	80.6%	10.3%	7.4%
After	216	1.9%	80.1%	7.9%	6.6%

In both populations majority of the students were unmarried females and about 45% were employed. A large fraction of students was of a similar age group, 20 – 25 years. This feature of the population may have facilitated group discussions.

Figure 1 indicates the perception of students, on a 4 point Likert scale, on the aspects of CL described by the statements listed in Table 2, before and after the Induction.

Table 2: Statements that described some aspects of CL which were used in collecting student perceptions on a 4 point Likert scale.

Number	Statement
1	Through group study ¹ I can clarify problems I face in studying subject material.
2	Through group study I can learn things I do not know, from others.
3	Sharing knowledge through teaching friends increases my knowledge in the subject.
4	Group study is a waste of my time.
5	Group study helps me in absorbing more subject material.
6	Group study motivates me to study.

For a given statement, m , if $n_\alpha(m)$ students have indicated their perception as $\alpha (= FA, A, PA, NA)$ in the Likert scale, then the relative frequency, $RF_\alpha(m)$, of α for that statement was calculated by

$$RF_\alpha(m) = [n_\alpha(m)/N] \times 100\%$$

where N is the population size. In figure 1, the first set of bars corresponding to a particular statement indicates the student perception on the aspect described by that statement before the commencement of induction. The second set of bars corresponding to the same statement indicates the student perception on the same aspect after the Induction.

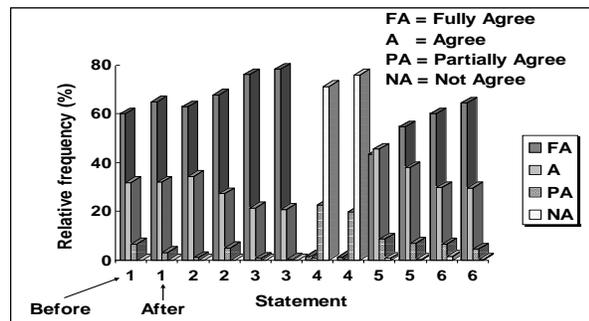


Figure 1: Student perception on aspects of CL listed in Table 2.

¹ The term “group study” was defined in the questionnaire as studying subject material by discussing with one or more friend/s.

The results obtained before the induction indicate that about 92% either fully agree or agree (FA/A) that he/she can clarify problems in subject material through CL. About 97% FA/A have stated that through CL he/she can gain new knowledge. About 97% FA/A that teaching friends increases his/her knowledge. About 71% disagrees that CL is a waste of his/her time. About 89% FA/A that CL helps absorbing more subject material. About 90% FA/A that CL motivated them to study. Overall, the results indicate that the students who participated in the induction have a favourable perception of CL even before the commencement of the induction. This may be considered as a positive sign towards engagement in CL. Comparison of the height of bars corresponding to the same perception of the same aspect, before and after the induction, indicates that the change in perception on a given aspect of CL brought about by the induction is marginal. This indicates that one has to change the nature of the Induction if one wants to improve student perception on any of these aspects, significantly.

The change in relative frequency of perception, of the usefulness of CL, brought about by the Induction, on a 5 point Likert scale, is shown in Figure 2. The change is calculated as $[RF_{\alpha}(after) - RF_{\alpha}(before)]$, where $RF_{\alpha}(before)$ and $RF_{\alpha}(after)$ are the relative frequencies of perception α of the usefulness of CL, before and after the Induction, respectively. Results indicate that the Induction has been effective in enhancing the perception that CL is very useful for students, by about 20% which is substantial.

This is an interesting result since it indicates that the induction has enhanced the belief that CL is very useful in spite of the fact that it has no substantial influence on the perception of some individual aspects of CL. We argue that in inspiring students in engaging in CL, perception on usefulness is more important than the perception on individual aspects since the former is a combined effect of the latter. As such we argue that the nature of the induction is appropriate for inspiring students for CL. Furthermore, in response to our survey after the induction, 95% of the participants indicated that they have decided to engage in CL in the future. As such, we argue that at the end of induction 95% of students has got inspired in engaging in CL in the future which may lead to voluntary formation of learning communities.

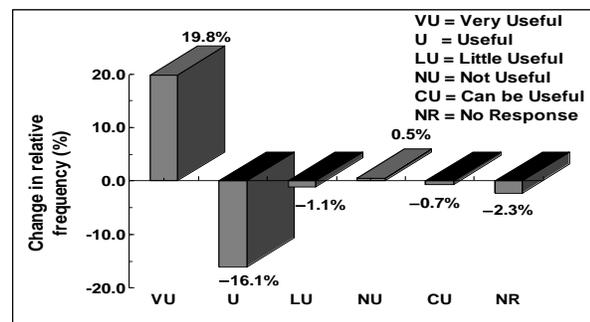


Figure 2: Change in student perception on the usefulness of group studies of

CONCLUSIONS/RECOMMENDATIONS

Results indicate that at the beginning of induction the students had a favourable perception of the aspects of CL listed in Table 2. The nature of Induction is such that the change in student perception on the above aspects brought about by it is marginal. However, the induction has been successful in enhancing the perception of students that CL is very useful for them, an overarching aspect which is more important in inspiring students for CL than individual aspects listed in Table 2, by about 20%.

Our data strongly suggests that at the end of the induction almost all the students (95%) got inspired in engaging in CL. It can also be concluded that the nature of the induction conducted by the Faculty of Natural Sciences is appropriate for inspiring students for CL.

Inspiration generated at induction may lead to the voluntary formation of learning communities. However, there is no guarantee that a large number of students will actually do so in the future. To assess the actual impact of Induction in the formation of learning communities one has to do a follow up study which the authors have planned to undertake.

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A STUDY ON THE EFFECTIVENESS OF CONTINUOUS ASSESSMENT AS A LEARNING TOOL

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INTRODUCTION

Assessing a student is not merely assigning a mark or a grade to reflect the achievement of the learner at the end of studying the course. McMillan (2000) points out that assessment enhances instruction and also influences student motivation and learning. Muirhead (2002) reports that assessment is an important element in the teaching and learning process that challenges instructors to consider evaluation techniques that meet the learning needs of today's adult learners.

Teaching and learning is a continuous ongoing process. It is essential to have ways of assessing the achievements of the students as they proceed. The instructor is left with the challenge of identifying discrete time points at which the assessments should be done and to decide on the kind of assessment strategies that are most appropriate at the selected mile stones.

The Bachelor of Science (B.Sc.) degree programme at the Open University of Sri Lanka (OUSL) is offered as a two-semester program. Each semester is around 15 weeks long. Carefully designed self assessment questions in the course material provide the learner an opportunity to continuously assess themselves as they study the lesson material. Students are more formally assessed through continuous assessment tests (CATs) and end of course final examinations. In the case of mathematics courses offered by the Faculty of Natural Sciences, formal feedback for the learners as well as for the teachers are obtained through two CATs, of which one is an open book test and the other is a no book test. The continuous assessment mark (CAM), computed as a weighted average of the two continuous assessment marks with a weight of 0.6 for the best mark and 0.4 for the other, is used to determine the eligibility to take the end of course final examination. Current practice is to use a CAM of 40 as the eligibility cut off mark that determines the eligibility to take the end of course final examination. The overall final mark for the course is determined as the average mark of the continuous assessment mark and the end of course final examination mark (FEM). A minimum overall mark of 40 is required for a pass grade.

It is worth examining how effectively the students use continuous assessment (CA) as a learning tool. The study described here attempts to address this issue through a careful study of the assessment marks for several mathematics courses offered for the B.Sc. degree programme.

AIM AND OBJECTIVES

The main aim of this study is to examine the effectiveness of CATs as learning tools and to find out how the performance at these tests relate to that of final examinations.

Specific objectives of the study are

To study the associations of CA marks with the final examinations marks.

To assess the effectiveness of CA marks in predicting the final examination marks.

To examine the effectiveness of CATs as learning tools.

METHODOLOGY

The marks pertaining to three Level 3 mathematics courses of the B.Sc. Degree Programme PCU1141, APU1141 and PCU1142 in the academic year 2011/2012 are used for this study. PCU1141 and APU1141 are identical but PCU1141 is offered by students at Level 04 who are not offering Applied Mathematics as a major discipline as an open elective course. APU1141 is

offered by students at Level 03 who are offering Applied Mathematics as a major discipline. PCU1142 is offered by students at Level 04 who are not offering Pure Mathematics or Applied Mathematics as a major discipline.

Scatter plots are used to examine the type of association between CAM and FEM. The strength of the linear association between the CAM and the FEM is measured by the Pearson correlation coefficient (Cox and Hinkly (1974)). The effectiveness of CAM in predicting the FEM is studied through a regression analysis.

To study the effectiveness of CATs as learning tools we need to do a careful analysis of information collected from students on how they feel about the course as well as observations from instructors and also analysis of CAT and FEM marks. In this report, we present the latter, which is, how the performance of students at the final examination had varied depending on the performance at the CATs.

RESULTS AND DISCUSSION

Here we report the results obtained by analyzing the CA marks and final examination marks of PCU1141/APU1141–Basic Statistics and PCU1142–Bio Statistics. Scatter plots of final examination marks against CA marks of all three courses indicated a linear association between the two variables but the points were widely scattered suggesting that the association is not strong. As we already noted only those students who obtain a minimum eligibility mark of 40 are permitted to write the final examination. Therefore, the results we report below are based on the performance of those students. Table 01 summarizes the descriptive statistics and the Pearson correlation coefficient between the CAM and the FEM.

Table 01: Descriptive Statistics

Course Code		Descriptive Statistics						Pearson Correlation Coefficient
		No. observations	Mean	Median	Standard deviation	Minimum	Maximum	
PCU1141	CA M	53	49.75	49	7.45	40	65	0.213
	FEM	48	54.85	54	10.65	37	86	
APU1141	CA M	104	47.60	45.50	8.36	40	79	0.467
	FEM	78	52.44	52.50	10.86	27	74	
PCU1142	CA M	152	47.15	45	8.046	40	83	0.438
	FEM	116	43.59	40.50	16.16	16	88	

The first column in Table 01 indicates that the number of students who had taken the final examination in each course is less than the number of students who had taken the final examination. This means all students who are eligible to take the end of course final examination have not sat. At the OUSL, once students are eligible for a course, they are permitted to postpone sitting the final examination. For the courses we are examining, the permitted period is three years including the year in which they register.

The second and third columns of Table 01 indicates that for each of CAM and FEM, the sample mean and sample medians are quite close suggesting that the distributions of continuous assessment marks and final examination marks are likely to be symmetrically distributed. Also,

the average marks for the two tests in each case are quite similar. However, the standard deviation of the end of course final examination marks for each course is bigger than that for the CA marks. Thus, the students end of course final examinations seem to discriminate the students much more than the CATs. In here we note that CATs are held at the course at an early stage in the learning process with the objective of giving feedback for learners as well as for teachers. Thus, more rigorous testing which focuses on the cognitive domain is not much deeply tested in the CATs. This is not so for the end of course final examinations. Thus, as one would expect, the final examinations that also focuses on the cognitive domain seem to separate out the students more, thus rendering large standard deviations for final examination marks.

The last column of Table 01 gives the Pearson correlation coefficients that measure the strengths of linear associations between CAM and FEM. In all three cases, the Pearson correlation coefficients are small indicating that the linear associations between the CAM and FEM are not strong. The scatter plots in each case, further justifies this observation. Next we report the findings from fitting a simple linear regression model with CAM as the predictor variable.

Table 02: Regression Analysis output

Course Code	Regression coefficient of CAM (P-value)	Mean squared error	R ²
PCU1141	0.30 (0.145)	110.0	4.5%
APU1141	0.59 (0.00)	93.4	20.8%
PCU1142	0.85 (0.00)	212.8	19.2%

The first column of Table 02 indicates that in the case of PCU1141, the CAM does not significantly contribute to predict the variation in the final examination mark. In APU1141 and PCU1142, the CAM contributes significantly to predict the final examination mark but the last column indicates that CAM alone is not adequate to explain the variation in the final examination marks. We already noted that the scatter plots of data in each case indicate a linear relationship between the two variables. Thus, the failure of CAM alone to adequately describe the variation in FEM can be due to the existence of other factors having a significant effect on the FEM or due to the differences in the effects of CAM as learning tools for different learners. To further study this, we examined the unusual observations highlighted by the regression model fit.

Table 03 presents the number of unusual observations the CAM, FEM and the fitted value for the FEM rounded off to the nearest integer, and the standardized residual (std.resid) for each unusual observation Table 03 highlights information on two types of unusual observations. The observations with large absolute values for standardized residuals correspond to points that do not agree with the fitted linear regression model. It is interesting to note that all of these correspond to students with low CAM marks. In PCU1141 and PCU1142, the large standardized residuals are positive. This means these students at the final examination have performed better than that predicted from the fitted model for their CAM marks. Since both test scores are symmetrically distributed with similar location parameters, this may be due to effectively using CAM as a learning tool. It is worth noting that PCU1141 and PCU1142 are offered by students at Level 04 and they have effectively used CAM as a learning tool. In APU1141, standardized residuals with large absolute values are negative. Thus, those students have performed poorly compared to what is predicted from the simple linear regression model for their CAM. Thus, for them, lower CAM has adversely affected their learning process. APU1141 is offered by students at Level 03. They have not effectively used CAM as a learning tool, but rather this seems to have got an adverse effect.

We also analyzed the CAM of students who were eligible but have not taken the final examination. We find that in PCU1141, APU1141 and PCU1142 9%, 25% and 24% respectively

have not sat. Among only those with CAM less than 50, the relevant figures for PCU1141, APU1142 and PCU1142 are 12%, 44% and 31% respectively. Thus, not sitting for the final examination in each course is more prominent among the students with lower CAM, This further emphasizes that the lower CAM has adversely affected the motivation of students to take the final examination further study is needed to confirm this observation.

Table 03: Details on unusual observations

Course	Number of unusual observations	Details on unusual observations			std. residual
		CAM	FEM	Fitted Value	
PCU1141	1	44	86	53	3.20
APU1141	6	40	27	48	-2.16
		47	30	52	-2.27
		49	32	53	-2.18
		68	-	64	-
		68	46	64	-1.94
PCU1142	9	79	68	70	-0.28
		41	73	38	2.40
		46	75	42	2.24
		47	76	43	2.25
		51	80	47	2.29
		64	88	58	2.12
		67	-	60	-
		76	58	68	-0.73
78	60	70	-0.72		
83	71	74	-0.23		

CONCLUSIONS/RECOMMENDATIONS

This study highlighted that in PCU1141 and PCU1142 students with lower CAM have performed better than what is predicted from the model fit. In contrary, in APU1141, students with lower CAM have performed poorly compared to what is predicated based on the CAM. The courses PCU1141 and PCU1142 are offered by students at level 4 whereas APU1141 is offered by students at Level 3. This suggests that students at the start of the degree programme have not effectively used the CA as a learning tool as compared to those at the higher level. Thus, we recommend that it is needed to educate students on how to effectively use CA as a learning tool, especially at the commencement of the program.

The focus of this study is directly linked to improving student performance. This study only focused on the performance of students at the assessment tests. Further study by collecting information from students as well as extending this study to include courses at higher levels are recommended.

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A STUDY ON STUDENT PARTICIPATION IN AN ONLINE SUPPLEMENTARY COURSE IN ZOOLOGY

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INTRODUCTION

With the advancement of information and communication technology there is a noticeable worldwide growth in courses offered online. These online courses are useful to satisfy the growing demand for time flexible learning opportunities and to provide learner centered teaching and learning environments. Taking steps towards development of online courses, the Open University of Sri Lanka (OUSL) first introduced online courses in 2003 and by 2010 the number increased up to 74 (Jayatilleke, 2010). Most of these courses are supplementary courses where no compulsory assessment component is offered online, some others as blended courses where at least 20% of the assessment component is offered online and the rest as online plus courses where more than 20% of the assessment component is offered online.

The OUSL uses Manhattan and Moodle learning management systems (LMS) for online course delivery. The Animal Development B. Sc, second year course was offered online as a supplementary course in 2007 using the Moodle LMS template designed for OUSL courses. The initial objective of introducing the online component was to provide additional material for understanding the course content. In 2008, this course was improved categorizing activities under the topics of the course in the front page for easy reference. In 2010, more learning resources were added based on a survey done for the entire course. Further, the tutorial submission was accepted only through online. However, the marks of tutorial assessment was limited to maximum 2.5 added as bonus marks to the continuous assessment (CA) mark, to be fair for the students who lack facilities and find it difficult to obtain them.

The low student participation in spite of the above attempts drove us to find new ways to increase student participation. In 2013, two improvements were added; 5% of CA marks were given for the tutorial submission and one hour time period from 9 – 10 p.m. was announced for chatting in the 'Class Discussion'. Students were informed about the online component of the course, the activities available in it and the new improvements to it through the course information sheet delivered at registration. Further, at the first face to face student contact session (day school) and at the compulsory practical session of the course, an introduction to the online component of the course was given using a presentation. At the same time, the usefulness of the online component and the advantage of using 'Class Discussion' as a communication tool between student and teacher as well as among students were explained. As the participation for 'Class Discussion' was very low during the delivery, students were reminded at day schools to participate in it.

The research objective of this study was to

- assess the level of student participation in the online component,
- evaluate their preference of activities,
- investigate students' perception about the usefulness and attractiveness of the course as well as their difficulties and
- investigate the future improvements needed for the course.

METHODOLOGY

When the online course was ready for use with the uploading of students to the system, those who have registered for SMS service were informed by post and by an SMS message. As a part of the

registration process took place after the commencement of semester, there was a 3 weeks delay to upload the course. Therefore, the introduction to the course was done with a presentation and not by logging into the course. The number of students registered for the course was 336, and the active student number was 302. Probably due to the incomplete registration process or a technical error, only 244 students could be uploaded even with the second attempt.

According to Black, Dawson & Priem (2008) the activity logs in the LMS is an important resource to collect information about participation of student in online courses, giving opportunity to measure variables without causing any impact or inconvenience to students. Hence, a part of this study used activity logging data in the Moodle LMS to investigate the level of student participation in the online component, in different activities and the time that students logged in. These data were transferred to Excel, sorted and analysed.

The evaluation of student participation, students' perception about the usefulness and attractiveness of the course as well as their difficulties in participation in the online component of the course was studied giving a short questionnaire to students who attended the final examination and were collected before they left the examination hall. The questionnaires filled by the students who followed the course in 2013 were selected and those incorrectly or incompletely filled were removed. There were 144 correctly filled forms and it was 48% of the active student number.

RESULTS AND DISCUSSION

Of the uploaded 244 students, 166 have logged in to the course for at least one activity. This is approximately a 55% of all the active students and is 68% of the students uploaded to the system. Thus, the percentage of students not involved in the online cause was 32%. The results obtained from the questionnaire indicated a close value of 27%. The lack of ability to give hands-on experience on Moodle to students due to the high number in the course would have made this percentage high. A similar study done at OUSL has experienced only a 17% non-involvement. The success has been owing to low student number (55), provision of hands-on experience at the introductory session and grouping students online for the compulsory practical session (Liyanage, 2010).

Of the 166 students who have used the online component only 16 (0.1%) have viewed 'Contact information' of the teachers and 5 (0.03%) have viewed the 'Tutorial questions' given. The basic information given about the use of Moodle LMS and the study course has not been viewed by any of the students. These include 'Start Here', 'Announcements', 'Help wanted', 'Course information' and 'Grades' (CAT marks and Eligibility mark). This shows the students' non-usage of online information and their much dependence on the printed information. The preference of OUSL students for print medium than e-learning has been investigated in a study done by Ranasinghe & Gamini (2010).

Of the 166 students who have engaged in any of the activities, only one student (0%) was involved in the 'Class discussion' and there were only 4 posts by this student. Only 10 students (6%) have done at least one quiz, of the 5 available. The most involved activity was the 'Tutorial Assignment' and this compulsory assignment has been posted by 130 students (78%). Of the 9 Power point presentation (Ppts) provided, 100 students (60%) have viewed or downloaded at least one presentation. . However, a lesser number, 66 students (40%) have viewed at least one video clip of the 9 provided. The data obtained from questionnaires showed close values. Here, the number of students who had done any one activity was 105 (73%). Of these 105 students, 74 students (71%) have posted tutorial assignments, 58 (55%) hav

viewed or downloaded Ppts and 36 students (34%) have viewed video clips.

It seems that the students have targeted most on the tutorial submission and on learning resources in the online component. However, it is important to note that 22% who have logged into the online component have not posted the assignment. Fig. 1 shows the

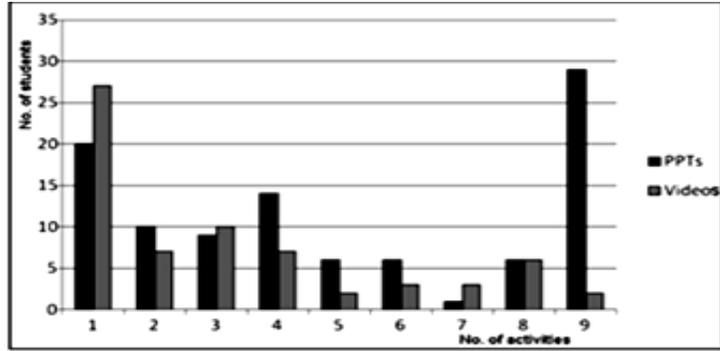


Figure 1: The number of students viewed the Ppts and videos

number of students viewed the 9 Ppts and 9 video clips. It shows that even these two activities that are highly engaged with by the students have not been completely done by most of them. There were only 29 students who have used all PPTs. The low involvement in the quizzes may be due to the fact that they are multiple choice questions and this type of questions were given only at the Continuous Assessment (CA) Test 1, which was held one month after the commencement of course.

The most inadequate participation occurred in ‘Class Discussion’ as there was only one student involved. In the questionnaires, 47% indicated the lack of time for involving in discussion continuously while 23% indicated unpreparedness with the knowledge on course contents for discussions. Lack of internet facilities continuously has mentioned by 12%, while the others (18%) have mentioned difficulty in discussing in English language, which may have made them shy due to exposure into a larger community. Although short, simple questions were given from difficult areas in the course for discussion, the difficulty in understanding these areas may have discouraged students in discussing them. As the sense of being in a community is important to increase student satisfaction, learning and retention in online courses (Rovai, 2002), students must be attracted towards ‘Class Discussion’ probably presenting very simple straightforward questions requiring short answers initially.

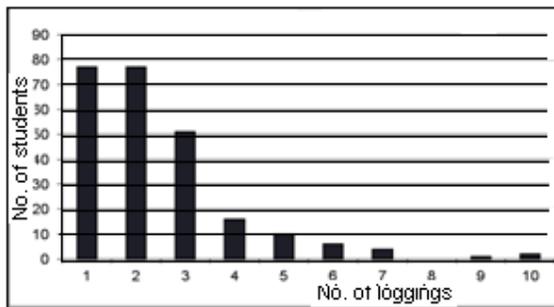


Figure 2: The number of loggings done by students.

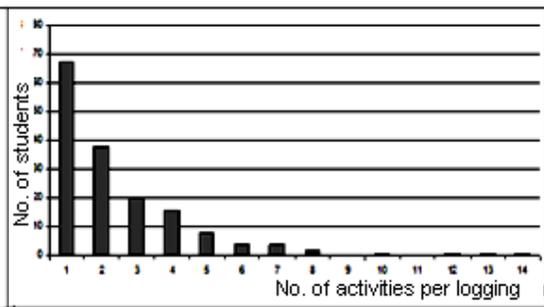


Figure 3: The number of activities per logging done by students

Fig. 2 illustrates that the number of loggings done by a student is mostly in the range of 1-3 and the average is 1.9. The number of activities done by a student per a logging is also very low (Fig. 3). This shows that students log into the online course rarely and they do not engage in much work even at the time they devote to it. This low participation can be due to the lack of time, low attractiveness of the contents or lack of resources. The lack of time seems to be a major factor, as 47% of students indicated in the questionnaires that the lack of time as the main cause for non-participation in the ‘Class Discussion’ and 35% of students who did not logged into the course

have given lack of time as the reason. The rest have mentioned lack of internet facility (42%), the inability to log in to the course (14%) and unfamiliarity with the use of the computers (11%).

In the questionnaires, of those who used online component, 72% have said that the contents of the online component were considerably good. 23% indicated the need to have more learning material while 5% have said that it was not useful. When considering the number of loggings throughout the period the course was delivered (Fig. 4), more loggings can be seen before the tests indicating the use of material for studying purpose. As 67% students have viewed at least one learning material, it was the most appealing part, except for the compulsory assignment. Therefore, it would be better to add more high quality learning material in the future to improve appeal. According to the logging time data, 63% students have logged in at least once out-of-office hours. This is almost similar to the data from questionnaires that indicated 66% of students have accessed from their homes. According to log reports, 34% have logged in only during office hours. This value is similar to data from questionnaires; 23% access by OUSL or National Online Distance Education service (NODES) facilities added to 11% access by facilities of offices or friends. This shows that considerable number of students have their own resources to use.

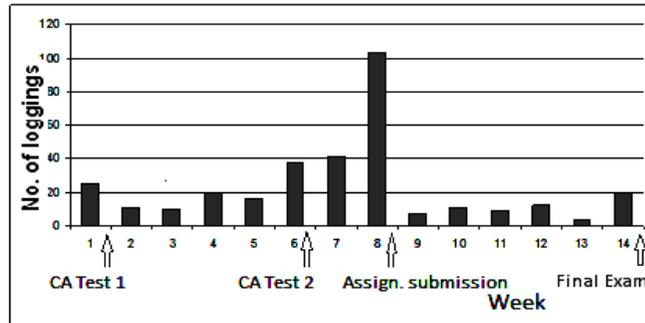


Figure 4: The number of students logged per a week through out the course delivery period.

CONCLUSIONS/RECOMMENDATIONS

This study indicates that students hardly find time for the online component even with different learning resources. Therefore, the learning resources added must be of very good quality, useful ones which save considerable time spent on understanding course material. Also, it shows that the online learning and discussion forums are unfamiliar to students and new strategies are needed to attract them until they realize the value of being in an interactive learning community.

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ASSESSMENT OF THINKING SKILLS IN A NON-TRADITIONAL UNDERGRADUATE CHEMISTRY LABORATORY CLASS

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INTRODUCTION

In a traditional laboratory class, where the procedure of an experiment is given, verbatim, step-by-step, a student may perform the experiment without thinking about the processes that occur within the apparatus. Using laboratory classes in developing scientific thinking is as important as developing specific subject related skills, if not more¹. As such, the practical classes of the chemistry course, CMU 2220, Concepts in Chemistry, in the BSc (Natural Science) programme of the Open University of Sri Lanka (OUSL), were developed in a novel format where the students have to uncover the procedure of each experiment through group discussion using a set of guiding questions². The questions possess the *cognitive challenge* and the group discussion creates the *collaborative environment*, two key factors necessary for developing thinking skills³. The perceptions of both staff and students indicate that the students improved their thinking skills by participating in the laboratory classes of CMU 2220². However, more objective measurement is necessary in optimising the strategy for inculcation of thinking skills during the laboratory classes. We report here the results of an attempt made in using multiple choice quizzes in achieving this objective.

Thinking skills may be broadly defined as “*the particular ways in which people apply their minds in solving problems*”³. A systematic categorization of various modes of thinking is often achieved using Bloom’s taxonomy⁴ where thinking processes are classified into a hierarchy. In increasing order of complexity they are recalling, understanding, applying, analyzing, evaluating and creating. Activation of a particular thinking process in Bloom’s taxonomy requires the activation of all the processes below it in the hierarchy. For example, the highest order process of creation requires the activation of all the other thinking processes. The importance of developing higher order thinking skills in science graduates is well accepted⁵.

The objectives of this investigation are to study the level of thinking assessed by the MCQs using Bloom’s taxonomy and to compare the distribution of marks of MCQs with the distributions of marks of more traditional continuous assessments, viz. theory continuous assessment marks and the laboratory report marks.

METHODOLOGY

The laboratory class in CMU 2220 was conducted on 5 consecutive days during which each student conducted 8 experiments. Half a day was spent on completing each experiment. The results presented here are based on the performance of the 106 students who participated in the laboratory class at Colombo regional centre of OUSL.

At the beginning of each half day, each student was given a handout of an experiment containing a series of questions. The students were required to spend about 15 minutes studying them individually. Then they were required to engage in group discussion (typically, 6 – 8 members) in finding the answers to the questions and uncovering the procedure which took about 30 – 45 minutes. Thereafter, they explained the procedure to a demonstrator. They were allowed to

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perform experiments in small groups of 2 – 5, depending on the availability of apparatus, only after the demonstrator was satisfied that they have uncovered a viable procedure. Essential theory of the experiments was given to the students as a course material book at registration and they were expected to study it before attending the laboratory class. After performing an experiment the students were required to submit a report as is done in a traditional laboratory class which was marked by staff. This mark may not be considered as a reliable assessment of the thinking skills of the students since the students were encouraged to collaborate in developing the report although they were required to write it individually in their own words.

A 15 – 20 minute MCQ paper was administered at the end of each experiment in assessing the thinking skills. It contained 5 problem type multiple choice items on the experiment. They were designed to invoke thinking processes in students. For example, the stem of an MCQ could be based on two alternative procedures suggested in overcoming a difficulty experienced by a (hypothetical) student, such as the non-availability of the ideal piece of equipment in the laboratory. The choices could be based on a comparison of the precision or accuracy of the procedures. If one or both the procedures mentioned above were not given in the course material and not discussed in the laboratory class then the students had to think systematically in finding the correct answer at the time of answering the quiz paper. As such marks obtained by a student in a MCQ paper is a measure of the thinking skills of that student.

MCQ quiz papers were administered for seven out of the eight experiments. Two of the authors separately analysed the seven MCQ papers in determining the highest order thinking processes invoked in answering each question based on Bloom's taxonomy. Then the results were compared and an agreement was negotiated in the few cases where there was a discrepancy⁶. Particular attention was paid for what is presented in the course material and handouts in making a reliable identification of highest order thinking processes invoked in answering each MCQ. For example, a question invoking a seemingly higher order thinking process was classified as recalling if it appeared in that form in the course material since a student who has studied the course material well only has to recall it in answering the question.

The Relative Frequency of invoking the thinking process, α , as the highest order process in the MCQ paper of the j^{th} experiment, denoted by $RF(\alpha, j)$, was determined using the relationship $RF(\alpha, j) = 100 \times [n(\alpha, j)/N(j)]\%$ where $n(\alpha, j)$ is the number of times the thinking process α is invoked as the highest order process in answering a MCQ in the quiz paper and $N(j)$ is the total number of times such thinking processes are invoked in the paper; i.e. $N(j) = \sum_{\alpha} n(\alpha, j)$. An

Average Relative Frequency, $ARF(\alpha)$, of invoking the thinking process α , as the highest order process, over the quiz papers was calculated using the relationship $ARF(\alpha) = \left[\sum_{j=1}^7 RF(\alpha, j) \right] / 7$.

$ARF(\alpha)$ is a measure of the percentage of the thinking process α is invoked as the highest order process in a MCQ paper.

RESULTS AND DISCUSSION

Figure 1 indicates the average relative frequency of invoking thinking processes in a MCQ paper as the highest order process.

Highest order thinking process assessed by the MCQ paper is evaluation since creation cannot be assessed using MCQs. On average 18% of MCQs invoked evaluation as the highest order

process. The MCQs that invoked evaluation process, invoke all the other lower order processes in Bloom’s hierarchy, viz. recalling, understanding, applying and analyzing. Hence the actual percentages of invoking the said lower order processes are higher than what is shown in Figure 1. For example, 1% of the MCQs invoke analyzing as the highest order process. Since it is just below evaluation (which is the highest order process invoked) 19% of the MCQs have evoked analysis. As such, 100% of MCQs has evoked recalling. 70% 25% of MCQs have evoked understanding and applying, respectively. However, to obtain a mark for a MCQ a student has to invoke the highest order process necessary in finding the answer to that MCQ since marks are given only for the correct answer.

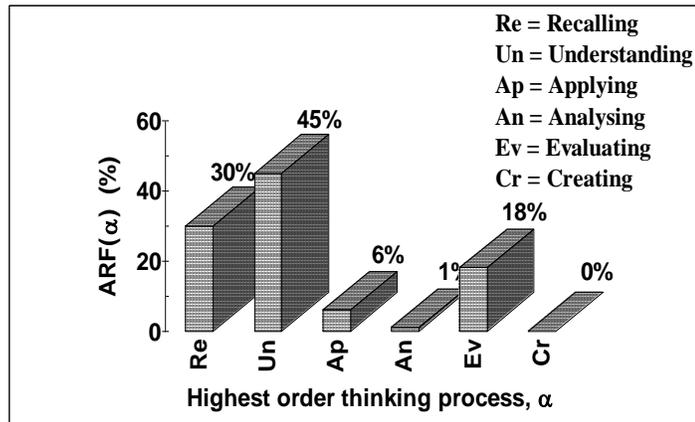
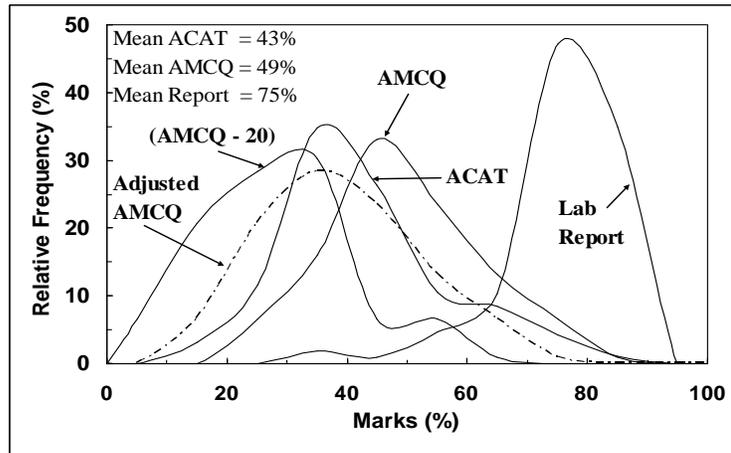


Figure 1: Average relative frequency of invoking thinking processes in a MCQ paper

CMU 2220 has 3 Continuous Assessment Tests (CAT) in its theory component. The mark obtained by a student averaged over these 3 tests (denoted by ACAT) is a measure of his/her academic achievement in the theory domain of the course. Similarly the marks obtained by a student in a MCQ quiz, averaged over all 7 such quizzes (denoted by AMCQ) is a measure of his/her ability in invoking thinking processes in the context of the 7 experiments.

Figure 2 shows the relative frequency distributions of ACAT, AMCQ and the laboratory report marks (together with their mean values).

As expected, the distribution of the laboratory report marks is skewed towards higher values with a mean of 75%. AMCQ has a nearly bell shaped distribution with a much lower average of 49%. However, one has to be careful in interpreting the distribution of AMCQ since the students can score by randomly marking responses in MCQs. Each MCQ has 5 possible choices. Hence on average a student can score 20% by randomly selecting responses to MCQs without invoking any thinking process. Hence, a lower bound to the distribution of AMCQ may be obtained by shifting the AMCQ by 20% towards lower marks which is shown in figure 2 as (AMCQ – 20). One may safely assume that the distribution of student marks which assesses the thinking skills of the students to lie between the two distributions mentioned above. An estimate of this “adjusted distribution” may be obtained by taking the average of AMCQ and (AMCQ – 20) which is indicated in the dashed dotted line in figure 2. This adjusted distribution is an estimate of the distribution of student thinking skills as



randomly selecting responses to MCQs without invoking any thinking process. Hence, a lower bound to the distribution of AMCQ may be obtained by shifting the AMCQ by 20% towards lower marks which is shown in figure 2 as (AMCQ – 20). One may safely assume that the distribution of student marks which assesses the thinking skills of the students to lie between the two distributions mentioned above. An estimate of this “adjusted distribution” may be obtained by taking the average of AMCQ and (AMCQ – 20) which is indicated in the dashed dotted line in figure 2. This adjusted distribution is an estimate of the distribution of student thinking skills as

assessed by the MCQs. As seen in figure 2, adjusted distribution is qualitatively similar to the distribution of ACAT marks. This may be interpreted as an indication that the student population who attended the laboratory class at CRC has achieved a level of competence in thinking skills which is similar to their academic achievement as reflected in CAT marks.

CONCLUSIONS/RECOMMENDATIONS

In the 7 MCQ papers used in assessing the thinking skills, 81% of the MCQs invoked the lower order thinking processes, recalling, understanding and applying. 19% were devoted for assessing higher order thinking skills, analyzing and evaluating. As such, on average, MCQ papers are biased in assessing lower order thinking skills. By including MCQs capable of assessing higher order thinking skills, one could improve the quizzes in assessing more higher order thinking skills.

The distribution of thinking skills of students as assessed by the said quizzes is qualitatively similar to the distribution of CAT marks, averaged over the three CATs, in CMU 2220 in academic year 2011/2012. As such one may conclude that the student population which attended the laboratory classes at CRC has achieved a level of competence in thinking skills (as assessed by the MCQs) which is similar to their academic achievement as reflected in CAT marks.

An examination of marks obtained by students for individual MCQs could be used in measuring the extent of the development of lower order and higher order thinking skills, separately, in the laboratory class. A similar analysis of the CAT papers and marks obtained by students for individual questions could reveal the extent of development of thinking skills in the theory component. Comparison of these results would reveal the impact of the laboratory class in the development of thinking skills of students. The authors have commenced such a study.

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PERCEPTIONS OF STUDENT TEACHERS OF AN ONLINE LEARNING ENVIRONMENT ON OPEN EDUCATIONAL RESOURCES FOR SCIENCE EDUCATION

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INTRODUCTION

The concept of Open Educational Resources (OER) refers to any educational resource that has been designed for use in teaching and learning that is openly available for use by educators and learners, without an accompanying need to pay royalties or license fees (Butcher, 2010). OER include learning objects such as lecture material, references and readings, simulations, experiments and demonstrations as well as syllabi, curricula and teachers' guides and these can be reused, revised, remixed and redistributed (Wiley, 2006). These openly licensed educational materials have tremendous potential to contribute in improving the quality and effectiveness of teaching and learning while providing many benefits for learners and educators.

The advantages of OER can be realized only through systematic design and creation of quality OER that would cater for specific requirements (Hatakka, 2009). The design and development of computer-based learning materials have been identified as a highly challenging and motivating task for educators (Karunanayaka, 2005; Karunanayaka, 2006). The essential need to pay attention to using appropriate instructional design approaches when developing online courses has also been emphasized (Karunanayaka & Thanaraj, 2010).

The Faculty of Education of the Open University of Sri Lanka (OUSL) initiated a research project to create an online learning environment on OER for Science education. This is developed in the Moodle Learning Management System (LMS) to be offered as a supplementary online course for Science teachers enrolled in the Postgraduate Diploma in Education (PGDE) and Bachelor of Education (Natural Sciences) Degree Programmes. The main aim of introducing this course is to promote use, adaptation and creation of OER by Science teachers. The course will further enable student teachers to gain an understanding about the concept of OER and their significance in the teaching-learning process, identify sources of OER available for Science education, create and share OER with their colleagues.

The research team, together with a group of Science teachers/teacher educators who were postgraduate students of the Faculty, engaged in this project that was conducted in several stages: Analysis, Design, Development, Implementation and Evaluation. Analysis of need, learner, task and context was conducted and decisions were made on designing information, instruction, interaction and interface. The design and development phases involved structuring the content, deciding on the instructional approach, designing graphical user interface, designing navigation structure, integrating course content in different media formats, incorporating strategies to enhance interactivity, and constructing the online course, named "OER4ScEd", in Moodle (Karunanayaka, Fernando & de Silva, 2013).

The course OER4ScEd was developed focusing on the existing Grades 10-11 National Curriculum on Science, relating to topics in three subject areas- Biology, Chemistry and Physics. The content was structured in the Moodle LMS under 06 main sections as follows: 1. An

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introductory section on OER—to raise awareness, develop skills and facilitate search/use/creation of OER; 2.-4. Subject-wise sections with selected OER—Biology/Chemistry/Physics;5. General Resource’s section to search and find OER; 6. A section to create / add OER by users. The selected OER in Sections 2-4 were presented under the prescribed competencies in Grades 10-11 Science curriculum in a structured manner, categorized as reading materials, activities and multimedia.

The developed course was piloted with a group of science teachers, who are current students of the PGDE programme, to find out their perceptions of the online course “OER4ScEd” with the aim of further improving it, based on their feedback. This paper is presented based on the findings of the pilot study.

The objectives of the study are as follows:

To find out perceptions of student teachers of the online learning environment “OER4ScEd”.

To find out strengths and limitations in information design, instruction design, interaction design and interface design of the online learning environment

To identify areas for further improvements in the online learning environment

METHODOLOGY

The pilot study was conducted using multiple methods of data collection. Twenty participants were selected from 34 PGDE students registered in the Science subject stream for teaching methodology, in the Colombo Regional Centre. Descriptive data were collected through an online questionnaire incorporated in the Moodle LMS, including 5-point rating scales on their perceptions of the online learning environment and its different design aspects, together with open-ended questions. An evaluation checklist on the OER presented in the online learning environment under different competencies of the three subjects, was also administered among the participants. In addition, focus group interviews were held with three sub-groups according to the three subject areas- Biology, Chemistry and Physics.

RESULTS AND DISCUSSION

Table 1: Perceptions of student teachers on the online learning environment “OER4ScEd”

Question	Aspect	Average rating (on a Scale 5-1)
How valuable to you has been the Online Learning Environment "OER4ScEd", in the following aspects?	Raising awareness about Open Educational Resources(OER)	3.8
	Having access to a variety of teaching-learning resources	3.7
	Opportunity to search for Open Educational Resources	4.0
	Sharing resources with others	4.0
	Engage in discussions on use of resources	3.8
	Opportunity to develop resources collaboratively	3.9
How satisfied are you with the following attributes of the online learning	Relevance of the learning resources	3.9
	Quality of learning resources	3.8
	Clarity of the learning activities	3.8
	Interaction opportunities with peers	3.8
	Flexibility in learning options	3.8
	Taking control of your own learning	3.5

environment "OER4ScEd"?		
Scale used: 5-Extremely; 4-To a great extent; 3-Moderately; 2-Just a little; 1-Not at all		

A majority of the participants were females (17/20) and below 40 years of age (15/20). A majority (13/20) had more than five years' experience as teachers and all claimed to have either excellent or average proficiency in English language as well as in computer use.

Perceptions of participants of the online learning environment, based on their responses to the online questionnaire are presented in Table 1.

Results revealed that the participants considered "OER4ScEd" valuable to them to a great extent (all ratings above 3.7) in providing an opportunity to identify, search for and share OER. Further, they were satisfied to a great extent (all ratings above 3.5) with its relevance, quality, clarity, interactivity and flexibility. More attention was required on allowing learners to take control of their own learning.

Table 2 presents a summary of student perceptions of information design, instruction design, interaction design and interface design of the online learning environment.

Table 2 : Perceptions of participants on information design, instruction design, interaction design and interface design of the online learning environment

Question	Aspect	Average rating (on a Scale 5-1)
How satisfied are you with the Information Design of the online learning environment, in following aspects?	1. An informative title	3.4
	2. Home page information	3.8
	3. Introduction to the course	3.8
	4. Learning outcomes	4.0
	5. User guidelines	4.0
	6. Menu/Contents with links	3.8
	7. Organizing/Structuring information	3.8
	8. Categorizing information	4.0
	9. Labeling chunks of information	3.8
	10. Use of a variety of strategies in presenting information	3.8
How satisfied are you with the Instruction Design of the online learning environment, in following aspects?	1. Use of a learner-centered approach	4.0
	2. User has control over his/her learning	3.8
	3. Searching for information encouraged	3.8
	4. Flexibility in learning provided	3.8
	5. Enhancing participation in learning activities	3.8
	6. Facilitating knowledge construction	3.8

How satisfied are you with the Interaction Design of the online learning environment, in following aspects?	1. Learner-Content Interactions	3.6
	2. Learner-Teacher Interactions	3.8
	3. Learner-Learner Interactions	3.7
	4. Learner-Interface Interactions	3.4
	5. Meaningful navigation among sections	3.5
	6. Social Interactions	3.8
How satisfied are you with the Interface Design of the online learning environment, in following aspects?	1. Page layout – Consistency	3.7
	2. Page Layout - User friendly	3.8
	3. Font types/sizes/colours used	3.5
	4. Background/Text colour contrast	3.6
	5. Images used – Motivational	3.9
	6. Images used - Relevant & Appropriate	4.0
Scale used: 5-Extremely; 4-To a great extent; 3-Moderately; 2-Just a little; 1-Not at all		

As evident from these results, the participants were satisfied to a great extent (all ratings ranging between 3.4 to 4.1) with different aspects of information, instruction, interaction and interface design of the online learning environment. Areas for further improvements were identified in the learner-interface interactions, navigation, font and background types and colours.

The arrangement of a variety of OER under different competencies of Biology, Chemistry and Physics in the existing National curriculum of Science at GCE O/Level, were found to be “very useful”, “effective” and “interesting”. Further, it was claimed that most of the design aspects were “clear”, “simple”, “user-friendly”, “flexible” and “motivating”. Certain concerns on some OERs were stated as “too advanced”, “too lengthy”, “content not relevant to syllabus”, and “cultural differences depicted in some examples”. However, overall, a positive impact was revealed as evident by the following quotes: “It save time and money”; “It helps to have better knowledge in the subject matter, to find answers for questions which arise while teaching, to engage with new technology and communicate with peers”; “It enables to teach with confidence and enables to go with the world” and “I think it opens us a new path to teach”. The main challenge faced by almost all participants was, coping with the technical problems. Suggestions of participants included making the environment more interactive, use of shorter video clips, including content directly tallying with the syllabi, addition of more multimedia materials, encouraging teachers to develop their own materials, to provide in Sinhala and Tamil media too and to expand to other subjects as well.

The evaluation checklist provided specific data on different OER presented under each competency in the three subject areas. It was identified that while a majority of the OER included were appropriate, there were some identified either as too advanced or too simple, which needed to be replaced. It was suggested to have a different link as “Additional Resources” to place in the advanced OER. It was evident through the focus group interviews that all participants were highly satisfied with the relevance, usefulness, organization and the effect of OER in the LMS. They further confirmed their confidence in making use of OER and effectively integrating it in

the three Science subject areas in order to make the classroom teaching-learning process more conducive.

CONCLUSIONS/RECOMMENDATIONS

The online learning environment “OER4ScEd” has been a new experience for the Science teachers. It was identified as very useful and relevant for them, as it broadens their scope of learning, saves time in searching for resources and improves the quality of teaching and learning. The strengths revealed were structured organization of the learning environment, relevance of OER, simplicity in use, and catering to different learning styles through incorporation of a variety of media. The learning environment can be further improved by adding more relevant OER and making the environment more interactive.

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CONTINUOUS LEARNING TRAITS AMONG KEY LEARNER COHORTS IN THE SOIL MECHANICS & INTRODUCTION TO ROCK MECHANICS COURSE

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INTRODUCTION

Soil Mechanics and Introduction to Rock Mechanics (Course Code: CEX4230) is a Level 4 course in the Diploma in Technology (Civil) Programme of the Open University of Sri Lanka (OUSL). The recent changes in Regulations and Rules have permitted Advanced Level mathematics-stream learners with a minimum of three passes, to enrol in the Faculty's Diploma in Technology study programmes. It is also observed that a significant number of national diploma holders and national certificate holders join the Diploma in Technology programme to pursue degrees in technology, in their respective fields of study.

The National Certificate of Industrial Technicians (NCIT), National Certificate in Technology (NCT) and National Diploma in Engineering Sciences (NDES) are programmes conducted by state sector Technical and Vocational Education and Training (TVET) institutes. The National Diploma in Technology (NDT) programme is offered by the Institute of Technology, University of Moratuwa. The Higher National Diploma in Engineering (HNDE) is offered by institutes affiliated with Sri Lanka Institute of Advanced Technological Education (SLIATE), of the Ministry of Higher Education.

The Open Distance Learning (ODL) method also expects learners to engage in continuous learning. Learners are assessed based on two Continuous Assessment Tests (CATs), three Tutor Marked Assignments (TMAs) and the laboratory activity (LAB). The Continuous Assessment (CA) mark represents their average performance during the study period, hence can be considered an indicator of continuous learning. Adult learners are expected to be self-directed learners (Knowles, 1975) practicing experiential learning (Rogers, 1980), and drawing upon their work experiences. However such traits aren't evident even among employed diploma holders.

This study compares the CA marks of a) national diploma holders, b) GCE AL Math-stream learners with three passes, and c) learners who have successfully completed a foundation programme. The findings enable the teacher to pay more attention to the different learner cohorts to address their specific learning needs, as explained in Biggs (2003).

METHODOLOGY

The study considers active learners enrolled in the CEX4230 course during the academic year 2012-13. It excludes 'non-starters'; i.e. those learners who did not enrol in the compulsory laboratory activity, who still maintained their enrolment status, without having de-registered from the course. Active learners were categorised based on their a) pre-qualifications, b) employment status, and based on c) the sector in which they are employed. CA grades are computed based on the same scheme used to compute final grades, as stipulated in the relevant regulations and rules.

RESULTS AND DISCUSSION

Results show that 132 out of 237 learners enrolled were non-starters. The balance 105 (44%) active learners belong to three main cohorts: a) NDT, NDES and HNDE national diploma holders

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(38.1%), b) GCE Advanced Level mathematics stream students with three passes 40%, and c) learners who have completed a foundation programme (16.3%) (refer Fig. 1).

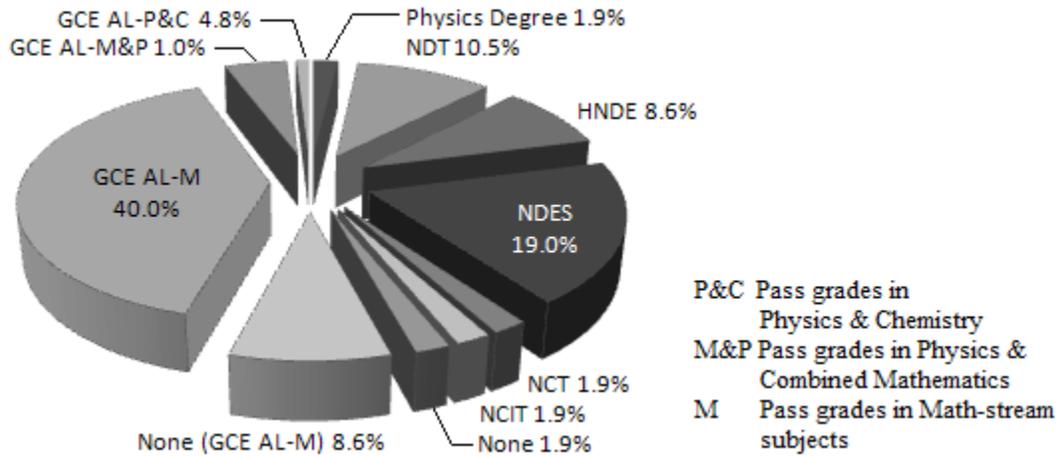


Fig. 1: Recognised qualifications of active learners.

The employment status of active learners (refer Fig. 2) indicates that 100% of diploma holders, 48% of GCE AL Math-stream learners with three passes, and 67% of learners who have completed a foundation programme, are employed full-time or part-time. It seems that such employment is a necessity, rather than an academic requirement for adult learners and learners of school leaving age.

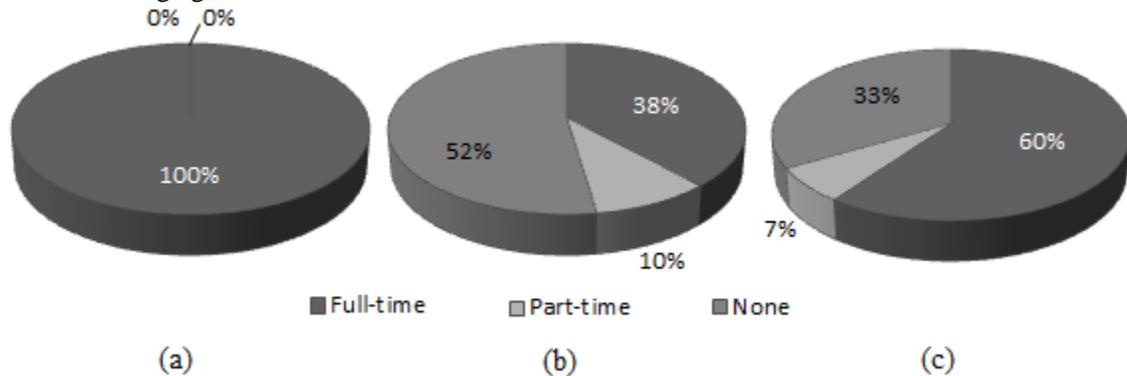


Fig. 2: Employment status of (a) diploma holders (b) GCE AL Math-stream learners with three passes and (c) learners completed a foundation programme.

Fig. 3 shows that 100% of diploma holders, 45% of GCE AL Math-stream learners with three passes and 82% of learners completed a foundation programme are employed full-time in the construction sector.

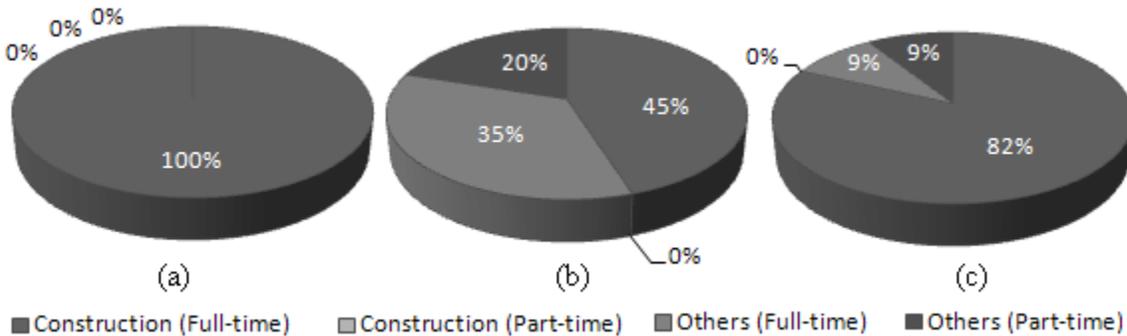


Fig. 3: Employment of (a) diploma holders (b) GCE AL Math-stream learners with three passes and (c) learners completed a foundation programme, in the Construction Sector.

Fig. 4 shows performance at CA, of the three main learner cohorts. The success rate (i.e. C-grade and above) of diploma holders is 20 out of 40 (50%); AL Math-stream learners is 35 out of 42 (83.3%) and learners completed the foundation programme is 12 out of 17 (70.6%).

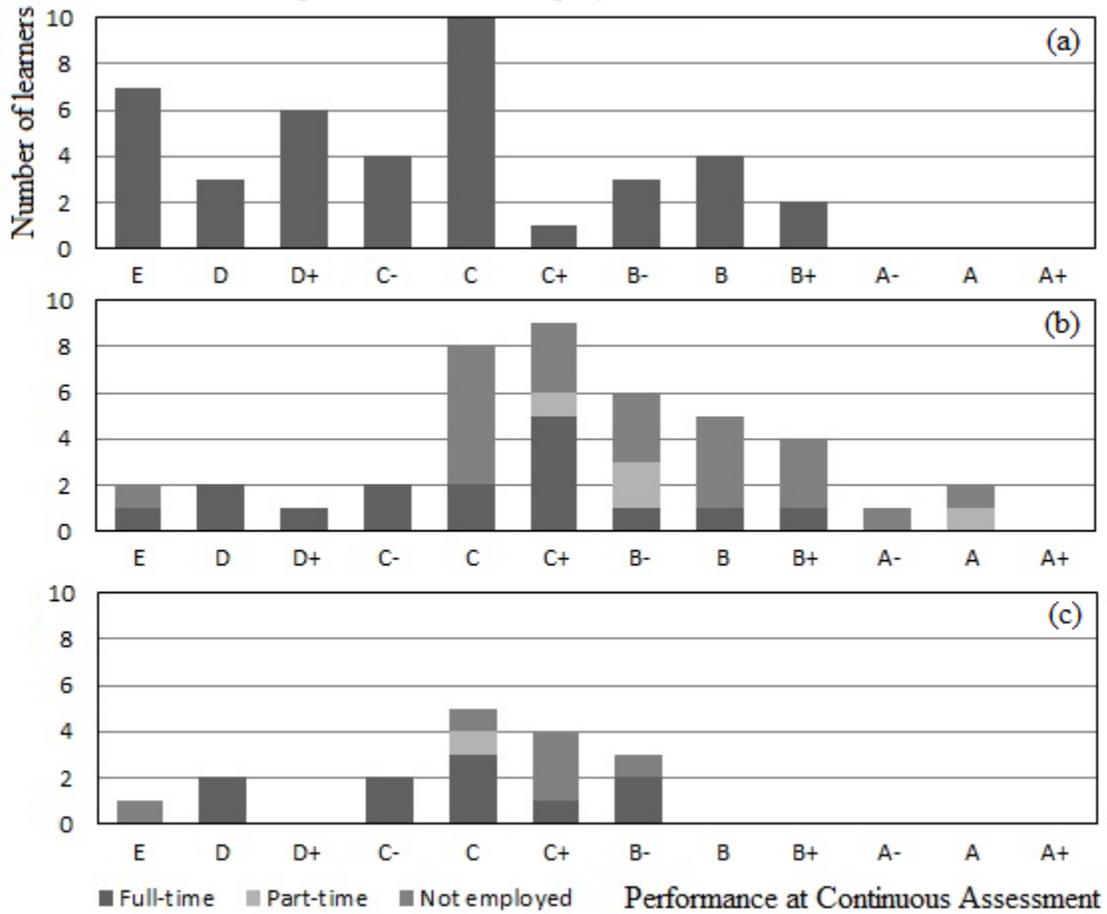


Fig. 4: Learner performance at Continuous Assessment by a) Diploma holders, b) AL Math-stream learners with three passes, and c) Learners completed the Foundation Programme.

Fig. 5 shows performance of diploma holders. Results show that learners with NDES qualifications have fared poorly compared to NDT and HNDE diploma holders.

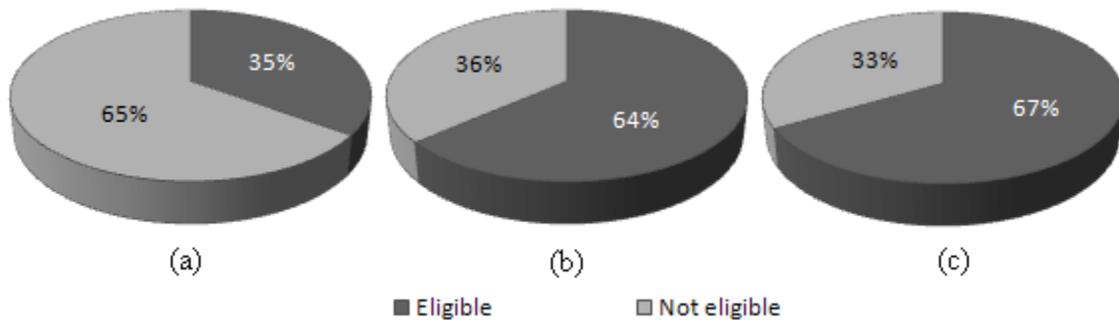


Fig. 5: Performance of diploma holders (a) NDES (b) NDT and (c) HNDE.

The observed low success rate of diploma holders compared to other two cohorts of learners wasn't an anticipated outcome. The following reasons may have attributed to their poor performance: a) As new registrants, learners may not have the necessary skills to practice ODL; b) Work pressure may not give them sufficient time to engage in self-learning; c) inadequacies in pre-knowledge required to construct new knowledge; d) learners resorting to a surface learning

approach whereas the course demands more in-depth learning. This study, however, does not investigate the reasons for poor performance.

CONCLUSIONS/RECOMMENDATIONS

This study shows that employed diploma holders have performed poorly at CA (i.e. 50%), in spite of their training and work experience in the construction sector. The mode of delivery seems to favour AL Math stream learners with three passes (i.e. 83.3%) and those learners who have completed the foundation programme (i.e. 70.6%).

The poor performance observed among NDES diploma holders compared to NDT and HNDE diploma holders, needs to be investigated. This could be done by monitoring learner interactions, assessment of performance, and by using a questionnaire survey.

The use of an on-line Virtual Learning Environment (VLE) is a viable mode that would enhance student engagement and support, in continuous learning. It could be used to address specific requirements of the three learner cohorts. Even though learners enrolled in this course have responded positively to the use of a VLE, the frequency of access by employed learners is found to be low (Ratnaweera, 2013).

A VLE can be used effectively to synchronise learner support with their learning. It may also serve as a useful tool to prepare learners prior to a learning event; to facilitate self-assessment and to encourage peer interactions; and to link their learning to work experience.

VLEs facilitate timely submission of responses to assignment questions, perhaps even at the end of each session. This may encourage learners to practice continuous learning.

Gibbs (2012) explains how formative assessments help achieve better learning than its summative counterpart. Though formative assessment methods aren't used at present, a few Tutor Marked Assignment questions of the formative type could be introduced via a VLE, which may enhance learner engagement.

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LEARNER SUPPORT IN DISTANCE EDUCATION – AN EXPERIENCE WITH THE POST GRADUATE DIPLOMA IN EDUCATION PROGRAMME AT OUSL

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INTRODUCTION

The term *open and distance learning (ODL)* and its definitions are relatively new in the field of education, having gained prominence only in the past 25 to 30 years. Distance education provides an alternative to traditional education. It provides an opportunity to learners to continue their educational activities in a convenient and flexible manner. In order to facilitate their learning, learner support services are offered. Learner support is a continuous process, which begins with the issuing of applications and ends with the awarding of a Degree. Numerous attempts have been made by researchers in order to define the term “Learner Support”. According to **Molefi, (1988)** learner support comprises “any **systems or procedures** that are **purposefully created and effectively utilized** by a distance education institution to **support and or facilitate teaching and learning at a distance**”.

The Open University of Sri Lanka (OUSL) was established in 1980 by the Government of Sri Lanka under the Universities Act No. 16 of 1978. The OUSL is unique in the national university system being the only university which offers programmes through the distance mode. The OUSL has adopted unique mechanisms to provide support services for its learners.

A number of research studies conducted in different distance educational institutions have identified the problems faced by the students in distance educational institutions and the importance of learner support services in order to overcome such problems (Ghosh: 2009, Lekamge *at el*: 1999).

The Post Graduate Diploma in Education Programme (PGDE) is one of the pioneering programmes offered by the Open University of Sri Lanka from its establishment. The present study focuses on how far the administrative and academic learner support services provided by the Department of Secondary and Tertiary Education (STE) have facilitated the activities of student teachers enrolled in the PGDE programme.

In line with the main objective the following research questions have been formulated:

1. What is expected by student teachers as learner support in an ODL system?
2. How far the existing learner support services have addressed the needs of the learner?
3. What were the problems faced by the student teachers when accessing learner support services?
4. What strategies had been followed by the student teachers to overcome such problems?
5. What suggestions had been made by the student teachers in order to strengthen the existing learner support services?

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METHODOLOGY

The population of the study comprised of 1200 student teachers who had been enrolled in Sinhala medium of the PGDE programme for the academic year 2011/2012 in all centres island wide. Out of the student population, a purposive sample was selected on the basis of the cluster system of the Regional and Study Centres of the OUSL. The selected cluster consisted of one Regional Centre and three Study Centres; Namely, Colombo Regional Centre, Ratnapaura, Kalutara and Gampaha Study Centres. The sample consisted of 25 percent of students who had been registered in the Sinhala medium at the selected centres. Data were gathered from only those who were present in the respective centre on the day of visit by the researcher. The main instrument of data collection was a questionnaire. Group discussions were also conducted in order to gather more descriptive data. These group discussions were conducted with 20 percent of student teachers who were included in the sample.

Centre	Number of Students Registered	Sample selected	Distribution of Questionnaire	Participation for Group Discussion
Colombo	200	60	60	12
Ratnapaura	94	30	30	6
Gampaha	100	30	30	6
Kalutara	100	30	30	6
Total	494	150	150	30

Table1: The Sample

Data collected through the questionnaire were analyzed quantitatively. Open ended questions and group discussions were analyzed qualitatively.

ANALYSIS

The sample consisted of 150 graduate teachers. From the sample 91% had graduated from the conventional university system of the country and 9% were graduates of the OUSL. It was revealed that a majority of the teachers were not engaged in academic studies through the distance mode at all prior to enrolling in the PGDE Programme.. However, the majority of students were, aware of what was meant by distance education.

The study revealed that almost all student teachers did expect learner support from the very beginning. This finding was supported by a study conducted by Lekamge *at el* (2009). 91% of the sample has stated that, as the programme was new and the mode of delivery was different, they were expecting learner support services from the institution. Those who had graduated from the OUSL have stated, though they were aware of the mode of delivery and the administrative system, they expected academic guidance and counseling in order to continue the programme satisfactorily. It was revealed that almost all students were expecting academic support as learner support in this programme. They wanted to pay greater attention to “understanding subject matter”, “contacting academics at any time they needed academic support”, “how to use the module” etc. It was revealed the student teachers were not aware that the support provided on administrative matters is also considered as a part of learner

In order to identify, how far learner support services have been able to address the needs of the learner, different statements were included focusing on different aspects of learner support services of the department. These statements focused on the pre-registration, registration process, inauguration of the programme, day schools, academic counseling on different aspects at different stages, tutorials, examination support and other services provided by the university,

while they engaged in the programme. It was revealed that 98% of the sample was satisfied with the instructions provided, prior to the registration and the registration procedure. They agreed that the instruction provided had helped them to complete the registration process satisfactorily.

Participation in the inaugural session is compulsory for all students. The inaugural session of the programme focuses on directing students on how they will be facilitated with learner support services while they are engaged in academic activities through the distance mode. The following table focuses on the students' responses in this regard.

Table2: Teachers' responses on the conduct of inaugural sessions

	Statement	Disagreed %	Agreed %	Neutral %	Not responded
04	I'm satisfied with the explanation made on process of the beginning of the academic activities till end of the programme	4	96	-	-
05	I'm satisfied with the explanation made on how academic activities will be continued.	4	95	1	-
06	I'm satisfied with the instructions provided how the practical components were carried out	3	94	1	2
07	I have a clear idea on the assessment process from the beginning to the end	31	67	-	2

As shown in Table no 2 it is revealed that, inaugural sessions have helped the majority of the students to understand how they could continue with the programme and how they could obtain learner support services while they were engaged in the learning process. However, 67% have stated that they were not clear about the assignment process at the beginning of the programme.

The main objective in conducting day schools is to provide opportunities for student teachers to get support from the tutorial staff to solve their academic problems. In Table 3, statement 09 to 13 focused on how students were aware of the support provided during the day schools.

It is significant that 88% of students have stated that instructions were not provided on how to use the module. At the discussion it was revealed that student had problems in identifying icons used in the modules which are used in house style format of the OUSL study materials. But, they were quite satisfied (58%) with the day school activities and they were able to understand how modules could be used accordingly.

Table 03: Teacher responses on learner support provided at the day school

Statement	Statement	Disagreed %	Agreed %	Neutral %	Not Responded
During the day school					
09	The instructions provided helped me to understand how I should engage in the learning process as a distance learner	32	68	-	-
10	Instructions provided on how to use the module were satisfactorily.	88	12	-	-
11	Day schools were conducted focusing on how to use the module accordingly.	42	58	-	-
12	Adequate instructions and help were provided as prior preparation to assignments	88	8	4	
13	Instructions provided to solve academic problems were satisfactory.	-	92	8	-

Further it was revealed that, though the academic staff had instructed student teachers to use the educational multimedia productions developed, a majority of the students in the respective regional centre were not interested in watching them.

Moreover, it was revealed that 92% student teachers were satisfied with the instructions provided during the day school in order to solve their academic problems. The problems have been minimized as the internal staff has engaged in conducting day schools. A majority of student teachers wanted to contact academics via telephone, in order to solve their problems. Most of their efforts had failed as the line was busy all the time. This led to a lot of frustration among students who felt that modern technology had failed to serve them at a time of need. Moreover it was revealed that they were not aware of other learner support facilities incorporated with modern technology such as e - mail facilities, web use, use of OUSL home page etc. This finding is contradictory with the findings of some previous research conducted by Hanafi *at el* (2005) that has explained how the learners have used technology as learner support in Malaysia.

In the OUSL context the process of continuous assessment plays an important role in the examination process. The students have to obtain eligibility to sit the final examination by obtaining a minimum of 40 marks for their continuous assessments. It was revealed that 88% of student teachers were not satisfied with the guidance provided on how they should engage in assignment writing. At the group discussion it was revealed that the majority of the student teachers were not satisfied with the grading and the feedback received for their assignments.

Providing academic support continuously is expected as learner support in distance education programmes. In order to provide academic support prior to the examination, tutorial classes were conducted. There, the students get the opportunity for solving their academic problems by referring to past papers and the module. Further, information on how the examination procedure would take place had been provided.

Table 04: Teacher responses on support provided at tutorial classes

Statement no	Statement				
		Disagree %	Agreed %	Neutral %	Not Responded %
	Tutorial sessions helped me,				
14	To be aware of the finalized examination time table	-	100	-	-
15	Was able to clarify academic problems in the modules	-	96	02	02
16	To understand how I should be prepared for the final examination.	-	91	08	01
17	To understand how I should answer for different papers at the final examination	-	97	01	02
18	Provided awareness on how the examination will be conducted	-	98	-	02
19	Made me aware of how I should overcome any problem faced prior to or during the examination period	-	100	-	-

It was revealed that the conduct of tutorial sessions was very useful for students in order to clarify their academic problems and to face the final examination with confidence. As the majority of tutorials were conducted by the internal academics the students had been benefited in both academic and administrative aspects. Further, the study focused on revealing student opinion on the instruction provided by the department and about the support provided from other divisions as learner support.

Table 05: Teachers' responses on the learner support services provided in relation to programme

Statement	Statement	Disagreed %	Agreed %	Neutral %	Not
20	I'm aware of the different divisions that I should contact regarding other problems	65	31	-	4
21	Satisfactory support was provided by the academic and non academic staff to get information when needed	6	92	2	-
21	The instructions provided helped me to solve my problems accordingly	-	94	6	-
23	Services provided by the other divisions were satisfactory.	8	87	-	5
24	Adequate counselling services were provided by the academics	02	92	01	5

The study revealed that, though the students had come to the end of the programme 65% of the sample were not aware of how they could obtain different learner support services relating to their problems. At the focus group discussion it was revealed that though the students had been provided an instructional manual at the registration, almost all student teachers had not paid attention to it. They always expected spoon feeding whenever they needed learner support. Student teachers were able to solve their problems with the guidance provided by the department. Further 92% of them were satisfied with the support rendered by the department and the other divisions of the OUSL.

Further, the study focused on the problems faced by the students while they were trying to obtain learner support services. It was revealed that 57% of the students had faced problems in answering take home assignments, such as understanding the questions, how to answer them, gathering required information etc. In order to overcome the problems, 78% of them have engaged in peer discussions, referring to the module several times. 14% of student teachers have shown interest in further reading in order to solve their academic problems. 17% of students faced problems in understanding the module. They had mentioned that direct translations from English into Sinhala, had confused them in understanding the subject content. As the day school topics had not covered such sessions, the problem had become worse. Students were able to discuss such sections during the tutorial sessions.

As a majority of the student teachers faced problems regarding academic support; they suggested that the number of day schools conducted be increased. Further it was revealed that the student teachers attached to three study centers were frustrated as they had to work with a few academics who visited their centre throughout the year.

SUGGESTIONS

In order to minimize the existing weaknesses in the student support student teachers as well as the Dept of STE should work together. Department needs to make arrangements to create awareness among students to make use of different learner support services available such as email, referring the OUSL web, on line help desk etc.

It is also suggested to conduct a pre-orientation programme in regional centers prior to registration. In addition to existing day schools, a day school session should be added on how to write assignments after writing the 1st assignment. Further students should be motivated to refer

to the instructional manual provided and student should have a positive attitude towards self study in an ODL system. Internal academics should be motivated to visit the study centers to conduct day schools.

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INTRODUCTION OF NEW INNOVATIONS TO CONTINUOUS ASSESSMENT: A SUCCESS OR FAILURE?

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INTRODUCTION

Assignments play an important role in promoting two-way communication between the tutors and students who are geographically separated from each other. Depending on the challenging nature of assignments, their turn round time, constructive nature of feedback and objectivity of the assessment, students would not only be retained in the study programmes but also they would complete the programmes in a successful manner. Further, feedback would nurture several levels of learning support such as affective, cognitive, meta-cognitive, motivational and social levels which matters in distance education (Dionne et al :1999, Deschenes, Gagne, Bilodeau and Dallaire: 2001). On the other hand, teachers would be able to know the effectiveness of the instructional material and methodologies used, strengths and limitations of their students and their progress during a particular period of time through the assignments. As such, the Open and Distance Learning (ODL) institutions should establish systematic mechanisms to facilitate the two way communication through assignments in order to provide the intended benefits to both parties.

A number of research studies (Jayathilake, 1997, Jayathilake & Lekamge, 2002) which focused on the CA mechanism of the Post Graduate Diploma in Education programme of the Open University of Sri Lanka, had identified several problems and issues experienced by all stake holders and recommended long term and short term measures as solutions to those problems. As a result, the Faculty has devoted a considerable amount of its staff time to introduce several procedures which would have a direct impact on improving the quality of the CA mechanism. Those procedures included maintaining a participatory approach to setting and finalizing the assignments by course teams, conducting training programmes annually for marking examiners, decentralizing marking of assignments under assignment co-ordinators, monitoring marking with the support of assignment co-ordinators based at centres and conducting assignment-based day schools at least one per course. However, no extensive study has been carried out to evaluate the effectiveness of those new strategies introduced to the CA component of the PGDE programme. Therefore, an exploratory research study was designed and carried to identify the impact of the interventions on different stake holders, their strengths and limitations and to make suggestions for further improvement of the CA mechanism.

The following research questions were formulated in line with the main objective of the research study.

1. How far the participatory approach has been adopted by the faculty staff to develop the assignments?
2. How far the participatory approach has improved the quality of the set assignments?
3. How effective is the training mechanism implemented by the Faculty to train marking examiners?

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4. How effective is the conduct of assignment-based interactive day schools to improve student learning?
5. How far the centre co-ordinates have made an impact on improving marking of Assignments at centers

METHODOLOGY

The sample of the study included 290 Sinhala and Tamil medium student teachers registered in four regional centres namely Colombo, Matara, Jaffna and Kandy and two study centres namely Kurunegala and Batticaloa, 104 marking examiners, 21 visiting academics and 9 centre co-ordinators. Further, 6 course team members of the selected courses were also incorporated in the sample. It was assumed that the representative nature of the sample would permit researchers to generalize the findings for the total population.

In line with the survey research design, both quantitative and qualitative approaches were applied for data collection and data analysis of this study. A mixed approach which combined questionnaires, interview schedules, focus group discussions and observation schedules were used for collecting data from the relevant stake holders.

RESULTS AND DISCUSSION

1. USE OF PARTICIPATORY APPROACH

Through the exploratory interviews conducted with two course teams and the Assignment Co-ordinator of the Programme, it was evident that they were aware of the positive impact of the Course Team approach to the development of assignments, assignment-based interactive day schools and marking schemes. However, due to various reasons, academics had deviated from the said approach. It was further revealed through the discussions that only a few young members shoulder the responsibility of developing those material and they are supported by senior academics at the finalization stage.

The analysis of assignments used for the last two years (2011/12 and 2013/14) in relation to three subjects of the programme had revealed drawbacks in the format, practical nature, cognitive levels, novelty and challenging nature of assignments which could have been avoided by using the course team approach.

Table 1- Analysis of Assignments- 2011/12 and 2013/14

Aspects	ESP 2201	ESP 2202	ESP 2204
Format	Part 1= 5 Qs Part II= 1	Part 1= 5Qs Part II- 2	No parts 2 Qs only
Practical Nature	High	Low	Low
Cognitive levels	Both lower and higher levels	Mostly lower levels	Mostly lower levels
Novelty	All new	Some questions repeated	Some questions repeated
Challenging nature	High	Low	Low

Further, the analysis had revealed several problems in the coverage, wording and typography of assignments.

2. EFFECTIVENESS OF THE TRAINING WORKSHOPS CONDUCTED FOR THE MARKING EXAMINERS

The department conducts training workshops each year for all assignment marking examiners to familiarize themselves with their roles. It was assumed that their perceptions would provide a valid evidence for the effectiveness of the new procedures introduced.

Table 2- Perception of marking examiners on the aspects covered in the Training workshop

Aspects	Not satisfied	Moderately Satisfied	Fully satisfied	Total
(a) Introduction about the role of marking examiners	21	33	50	104
(b) Explanation given on the process of marking assignments	17	46	41	104
(c) Description about the guidelines of marking assignments	17	46	41	104
(d) Procedures to be followed to reduce variations in marking	23	46	35	104
(e) Advice on how to make comments on assignments	21	48	35	104
(f) Experience gained about the assignments and marking Schemes	17	54	33	104

As illustrated in Table 2, the number of marking examiners who were fully satisfied and moderately satisfied with regard to aspects covered in the training workshop were somewhat similar. However, it was evident that more than 1/3 of them had a negative perception with regard to all six aspects. This investigation was conducted soon after the training workshops have been conducted centre wise. Therefore, it was assumed that the marking examiners had provided relevant information with a fresh memory.

3. EFFECTIVENESS OF ACTIVITY BASED ASSIGNMENT DAY SCHOOLS (ABADS)

In order to avoid the limitations in the written assignments, Activity Based Assignment Day Schools had been introduced as a novel procedure to the PGDE Programme. The perception of visiting academics regarding the ABADS is illustrated in Table 4.

Table 3-Perception of visiting academics

Aspects	No. of respondents	Percentage
ABADS are more useful for sharing experience and developing soft skills	10	47.6%
ABDAS are more powerful and effective than other day schools	5	23.8%
Students are motivated through ABADS	5	23.8%
ABADS are more relevant and more practical	5	23.8%
Group interaction is very high	4	19,0%
Students are well prepared	9	42.9%
Student participation improved	21	100%

According to the majority of visiting academics ABADS are useful, powerful, effective, motivating, relevant and more practical (Table 3). Further, during ABADS the preparation of student teachers (9) and close interaction within the groups (4) were high which could be identified as the indirect achievements of such day schools. It was interesting to note that the student teachers also put forwarded the same view points (Table 4) about the ABADS. The majority of student teachers were either fully satisfied or satisfied with the ABADS.

Table 4- Student teachers perceptions on ABADS

No.	Statements	5	4	3	2	1
6.2	ABADS are having an important impact on us	74	129	28	37	21
6.12	ABADS are more effective than written assignments	151	79	17	11	15
6.13	ABADS are more useful for us	158	73	16	11	17
6.14	ABADS are more effective than written assignments	162	71	16	08	17

1. Highly disagree 2. Disagree 3. Neither disagree/Nor agree 4. Agree 5. Highly agree

However, the direct observations conducted by the research team on ABADS had revealed some drawbacks in the way that ABADS are conducted by the visiting academics. Therefore, the benefits for student teachers, visiting academics and for the institution could be improved through a proper monitoring and supervision mechanism.

IMPACT OF THE CENTRE CO-ORDINATORS ON STREAMLINING THE PROCESS

In relation to the PGDE programme, there are temporary co-ordinators appointed for each regional or study centre to streamline the distribution and marking of assignments and return of assignments to students. The interviews conducted with them had revealed a positive picture about their contributions. However, the analysis of comments on assignments revealed several problems pertaining to marking of assignments and giving feedback on assignments. As

immediate counterparts, coordinators had not taken necessary steps to improve the existing situation. The contributions of centre co-ordinators were minimal with regard to monitoring of marking, provision of feed back for marking examiners and reporting to the Faculty about the problems of marking of assignments.

Observations of marked assignments had revealed that a considerable number of marking examiners were at a moderate level in giving positive feedback (9/22), indicating correct answer (11/22) and directing student teachers for further learning (12/22) which could have been improved through the mediation of the centre co-ordinators.

CONCLUSIONS

There are substantial improvements in the CA mechanism of the PGDE Programmes when compared with the previous findings reported by Jayathilake & Lekamge(2002). However, it is observed that the inability to follow the course team approach by the faculty staff led to various limitations in the quality of assignments developed. The perception of marking examinations about the training workshops was positive though there is a need for taking steps for overall improvement of the workshops. From the point of view of visiting academics and student teachers, the Activity Based Assignment Day schools are very effective. If such day schools do not come up to the expectations of the faculty staff urgent action is needed to get them to the right direction. One major recommendation would be to implement a close supervision and monitoring system by the faculty staff on the CA mechanism of the programme.

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WEB VISIBILITY OF SCHOLARLY PRODUCTIVITY OF TEACHING STAFF OF OPEN UNIVERSITY OF SRI LANKA

Anusha Wiyaratne¹

INTRODUCTION

Universities have played the key role in knowledge production over the years while other sectors such as industrial, hospital, government those who actively participate in knowledge producing movements heavily depend on university expertise. Therefore, it is very important for the universities to make sure that they produce their share of knowledge towards the development of the country and for the wellbeing of mankind. Besides, both universities and scholars should pay attention to proper dissemination of solemnly earned outcomes with fellow colleagues and industrialists across the boundaries in order to inspire further research and encourage practical applications. Fortunately, the emergence of World Wide Web has launched new avenues for scholars and scientists in publishing and disseminating their work (Bauer & Backkalbasi, 2005). In addition, publishing in the web, opens up invaluable opportunities for the institutions and scholars to rise in their position in the webometric ranking, which is a widely accepted measurement of academic excellence. Hence, academic institutions all over the world are trying their best to enhance their web presence by reformatting their web policies and initiating open-access archives in order to increase the volume and quality of their electronic publications.

There is a newly developed interest among the Sri Lankan universities to ascend the webometric ranking on par with the world universities. Several Sri Lankan universities including the Open University of Sri Lanka (OUSL) have already established open access repositories to promote the web visibility of their research output and academic activities. It is important for universities and their scholars to be vigilant on the growth of their web visibility to make certain that their web presence accurately reflects their academic activities. The substantial development of literature on related studies (i. e. Bauer & Backkalbasi, 2005; Notess, 2005; Meho & Yang, 2007, Kousha & Thelwall, 2007; Abdoli & Kousha, 2008) indicates the enthusiasm of researchers at international level. However, there is hardly any published study that investigates the web presence of individual scholars or institutions in Sri Lanka. This paper describes the findings of a study that examined the web presence of the scholarly production of the teaching staff of the OUSL.

METHODOLOGY

The present study is aimed at revealing the current status of web presence of OUSL academics while highlighting the contribution of each academic Faculty and their senior staff towards the web visibility in terms of scholarly publications.

The study aims at achieving the following specific objectives:

- Ascertain the publication rate of the members of teaching staff of OUSL
- Ascertain the rate of citations received by publications
- Ascertain the yearly distributions of publications

Level of web visibility of 260 members of the teaching staff of OUSL was assessed during the study. The population frame was developed based on the academic staff profiles appeared in the Faculty pages of OUSL website at <http://www.ou.ac.lk> during the last week of February 2013.

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Google Scholar (GS) was selected to assess the web presence of the staff members after a preliminary testing session that measured the strength of 3 free tools, namely, GS, Microsoft Academic Search and Elsevier Sirius. GS produced the highest number of hits for the 8 selected OUSL academics. Besides, several researchers such as Notess (2005), Meho & Yang (2007), Kousha & Thelwall (2007), Abdoli & Kousha (2008) had accepted GS as an excellent free tool for scholarly information discovery that is also capable of tracking ‘hidden’ citations and non-traditional forms of publications.

The GS data were harvested during the first 3 weeks of March 2013. During the first phase, names appeared in the staff profiles were used as the search term. During the second phase 2-3 different combinations of names (i.e. first name plus last name, initials plus last name) were used to track the citations of the members whose citations could not be located during the first phase. Use of different names by the same individual and two different authors with the same name were the main difficulties encountered. In order to minimize the error rate, the researcher took several precautions such as personally contacting the relevant member of the staff or re-run the search after adding discipline tag or university tag to the search term. Ultimately, it took nearly 50 hours of work to clarify uncertainties, verify accuracy and relevance of hits and to cleanup the duplicated citations.

RESULTS AND DISCUSSION

The level of web visibility of 260 members of teaching staff of OUSL representing the four Faculties– Education (Edu), Engineering (Eng), Humanities and Social Science (HSS), Natural Sciences (NSc) – was assessed in terms of number of publications, number of citations received per publication, and the years of publication. The web presence of senior staff members was calculated separately in order to identify their contribution towards the overall web presence of the University.

Distribution of staff

In all Faculties, except the ‘Edu’, number of senior staff exceeded the number of junior staff. Out of the total number of 260 staff members 56% (145) represented the senior staff category while 44% (115) represented the junior staff category. The Figure 1 illustrates the distribution of staff, Faculty wise.

Scholarly productivity of OUSL teaching staff

A total number of 578 publications were located during the study with the highest number of publications (221) from the ‘NSc’. Table 1 presents the distribution of the publications.

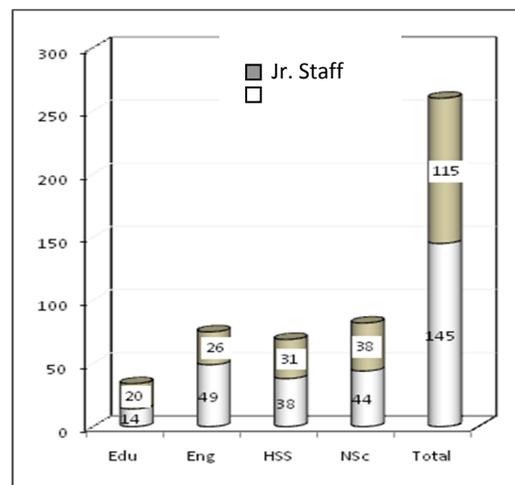


Figure 1 Distribution of staff Faculty wise

Table 1 Distribution of publications Faculty wise

	Edu	Eng	HSS	NSc	Total
No. of publication by all staff	54	174	129	221	578
No. of publication by sr. staff	52 (96%)	157 (90%)	120 (93%)	199 (90%)	528 (91%)

As shown in Table 1, contribution from the senior staff reported 90% or above in all 4 faculties. Another point that highlighted the significance of the senior staff is the number of articles published by individual authors. According to GS data, there were altogether 14 staff members who had published more than 10 publications and all 14 of them were from among senior staff members. Meanwhile, 18 out of total of 20 staff members who had published 5-10 papers are from senior staff.

However, there were 140 staff members whose presence was not shown in GS and out of them 50 (34%) were from senior staff. In other words, only 120 (46%) members out of 260, had at least one publication, according to the data harvested by GS during the study period. In addition, only ‘Eng’ reported over 50% of staff with at least 1 paper. Table 2 presents the findings.

Table 2 Staff members with at least one publication

	Ed u	%	Eng	%	HSS	%	NSc	%	Tota l	%
No. of Sr. staff with at least 1 paper	8	57	31	63	24	63	32	73	95	66
No. of Jr. staff with at least 1 paper	2	10	8	31	7	23	8	21	25	22
Total no. of staff with at least 1 paper	10	29	39	52	31	45	40	49	120	46

The publication rate per person was calculated based upon number of members with at least one publication to see the actual impact of the senior staff on the web presence of OUSL. The Figure 2 illustrates the findings.

Publication rate of senior staff is higher than the publication rate of all staff in all four Faculties. The ‘Edu’ reported the highest publication rate (6.5) by senior staff while the ‘Nsc’ reported the highest publication rate (5.5) by the total number of staff.

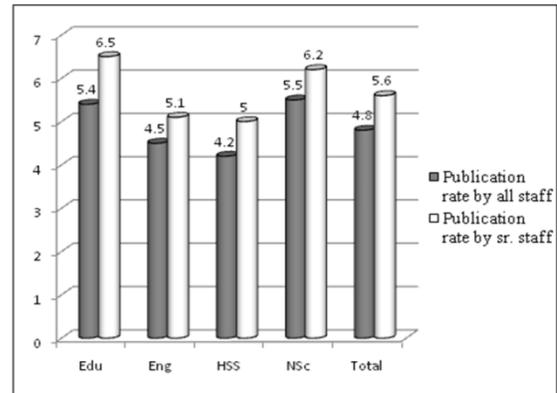


Figure 2 – Publication rate Faculty wise

Citations received by the publications

Number of citations received is considered as a measure of the impact of the cited work. Total number of 2217 citations was reported to be received by the 578 located articles, at the rate of 3.84. Highest rate of citations (5.5) was received by articles published by the ‘Nsc’ while the lowest rate of citations (4.2) was received by articles published by the ‘HSS’. Meanwhile, 69 (12%) publications received more than 10 citations and 52 (9%) publications received 5-10 citations. In this aspect, too, contribution of senior staff was quite significant. Out of the 69 publications that received more than 10 citations, 67 were authored by senior staff members. Further, all 52 papers that received 5-10 citations had also been authored by them.

Yearly distribution of publications

The yearly distribution of publications was observed in 4 groups as shown in Table 3.

Table 3 Yearly distributions of publications

	Edu	Eng	HSS	NSc	Total
Before 2000	9	50	30	98	187
2000-2004 (5 yrs)	2	18	20	19	59
2005-2009 (5 yrs)	29	55	43	59	186
2010-2013 Feb (3 yrs 2 months)	14	51	36	45	146
Total	54	174	129	221	578

‘NSc’ reported the highest number of publications for the period before 2000. Meanwhile, all the Faculties displayed a significant increase in the number of publications from the time period 2000-2004 to the time period 2005-2009. The growth of the publications seems to be further improving since 2010. Figure 3 illustrates the growth of publications rate from 2000.

CONCLUSIONS/RECOMMENDATIONS

The findings of the study are an eye-opener for the OUSL academic community, particularly, since GS showed no publications for over 50% of the OUSL teaching staff. It is true that GS has its own method of indexing that may cause failure in retrieving certain relevant hits. However, GS’s ability to generate results closer to actual has been highlighted frequently in the recent literature. Therefore, it may be sensible to state that the data discussed in the analysis represent the current status of web visibility of OUSL teaching staff up to an acceptable range.

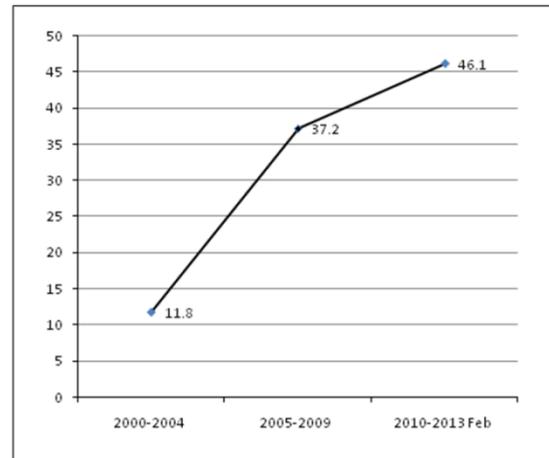


Figure 3 – growth of publications rate since 2000

The findings reveal a significant contribution from the senior staff and indicate certain advancements in the visibility of publications authored by OUSL staff in the recent years. Nevertheless, the fact that many OUSL scholars are not accurately represented in the web cannot be rejected. In other words, a portion of scholarly publications of OUSL academics are not visible through web mainly due to the format (printed only format) or the time of the publication (pre-web era). As a solution to this problem, OUSL Library introduced an open access archive which is in a platform that is readily indexed by GS and other search engines. As a result of these endeavors, during the year 2013 OUSL has shown advancement in its position both in the world ranking as well as in the ranking within the country than in 2012, where the world ranking has arisen from 5882 to 5829 and the country ranking from 8 to 7. However, climbing up the ladder is becoming more and more difficult with more and more competitors joining the contest. The study indicates a situation where the academic staff of the OUSL should divert their attention positively to maximize their web presence for the sake of the institution and to build up the academic status

nationally. A study that investigates the patterns of scholarly productivity of OUSL academics will be very helpful to identify the ways of enhancing the publication rate and promoting web visibility of their academic activities.

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A STUDY OF ACTIVITY BASED ASSIGNMENTS IN THE POST GRADUATE DIPLOMA IN EDUCATION PROGRAMME

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INTRODUCTION

A variety of assessment methods are used at the Open University of Sri Lanka to provide feedback to students and to assess their performance. In Open and Distance Learning, assessment has many dimensions; it can be formal or informal carried out by the learners themselves or by lecturers. In the Faculty of Education the main types of formative assessments that are being carried out are: presentations, home assignments and activity-based assignments (ABAs). Students who follow the Post Graduate Diploma in Education Programme have to complete 08 ABAs during their programme of study. Each assignment covers at least two sessions of the respective module. Students have to complete these assignments at the day schools and also have to engage in group activities and make presentations to complete these assignments. At the same time lecturers evaluate their performance individually and as a group.

“Assessment methods and requirements probably have a greater influence on how and what students learn than any other single factor” (Boud, 1988). Further, many studies stress the educational value of students learning together (e.g. Barnett 1994; Boud, Cohen & Sampson 1999; Jacques 1991; Johnson & Johnson 1999) such as improved analytical abilities, development of higher order cognitive skills, fostering deeper learning as a result of pooling of labour and peer teaching. Some studies refer to more pragmatic reasons such as increased staff workloads, fewer resources available for academics structuring their units, subjects and courses around group projects (James, McInnis & Devlin 2002; Morris & Hayes 1997).

According to Slater (1992) the benefit of assignments for student teachers can be listed as follows. First of all, they force student teachers to think professionally because in order to do assignments, student teachers have to gather data and then think about this data and process it. Also, they have to draw conclusions from the data gathered. This means that they have to work to meet high academic standards. In other words, they have to demonstrate that they are thinking professionally in answering the assignments, which is important for a teacher because thinking professionally and expressing ideas professionally is a crucial feature of an effective educator.

OBJECTIVES OF THE STUDY

There were four objectives in this study. They were: to examine both lecturers and students' perceptions of activity based assignments, to examine the problems related to activity based assignments and to make suggestions to develop the activity based assignment (ABAs) process further.

METHODOLOGY

The survey research design was used and the sample consisted of 120 Sinhala medium students in the 2010/2011 academic year in 3 Open University regional/study centres (Colombo, Kaluthara and Ambalangoda) and 06 lecturers who have evaluated ABAs in those centres. Since this was a

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minor study a purposive sample was used (40 students from each centre). The students' questionnaire was the main data collection instrument used and focus group discussions with both lecturers (06) and students (24) were also used to triangulate the data. Eight students from each centre were used to conduct 3 focus group discussions and the researcher took notes at the same time. The data analysis was done using both qualitative and quantitative methods. Limitations of this study were: selecting only 3 centres, only 120 Sinhala students enrolled in 2010/11 academic year and 06 lecturers

RESULTS AND DISCUSSION

Almost all the lecturers stated that ABAs were very interactive. Further, 2 lecturers stated that they also learnt some new facts through students presentations. Moreover, 95% of lecturers mentioned that students seemed to be active learners throughout the activities. Most of them stated that they were able to give immediate feedback to the students. They noted that some students asked several questions relating to their day to day teaching. For example, at the Educational Management ABA students had asked about the solutions for the problems faced by them at schools in relation to Educational management. Further, they stated that earlier they had to mark a number of assignments and it was very difficult with their busy work schedules and now they can manage the work load. And also, according to them team work, higher order cognitive skills, organizational and presentation skills have been increased due to this type of assignments. Further, all lecturers mentioned that the students attendance for the day schools had increased due to these type of assignments.

When considering students' perceptions of ABAs, the following conclusions can be drawn. Most of students (95%) noted that ABAs were more active and interactive. At the focus group discussions with students this fact could be proved. They mentioned that they were able to interact with both students and the lecturers. One student said that "We are inactive most of the times at the day schools where as in ABAs we are always active". Almost 91% of students agreed that, their active participation has increased due to ABAs. But only 78% students agreed totally that they received immediate feedback from the lecturers. At the focus group discussions most of students mentioned that when they engaged in group activities most of the lecturers facilitated them. But after making the presentations such feedback was not received as they had expected. It seems that lecturers have engaged in putting marks rather than giving feedback. Almost all students stated that all ABAs have covered more than two sessions in the modules and because of that they were able to get more information about those sessions.

All students agreed that ABAs were not time consuming. At the focus group discussions they mentioned that they had to spend a number of days to write a take home assignment. But within one day they were able to complete the ABA. Further, all respondents mentioned that their workload has been reduced due to ABAs if not they would have written 20 assignments. A majority (85%) of the respondents revealed that their team work abilities have improved due to ABAs. At the focus group discussions also they stated that they were able to get peers ideas through group work, because the members of a team represented different types of schools and back grounds. One student mentioned that "I'm teaching in a very rural, type 2 school. Therefore, my experience was very limited. However, due to ABAs I was able to extend my knowledge to other types of schools also, because I met a number of peers in ABAs."

Meanwhile, 80% of students agreed that ABAs were practical. It seems that most of them were satisfied with the activities included in ABAs. At the focus group discussions most of the students told that due to ABAs they were able to apply the theories in practical situations. One student noted that "After preparing a Blue print in Measurement and Evaluation I was able to prepare

question papers for my own students properly". Further she mentioned that she was able to understand it clearly rather than going through the module.

Nearly 85% students agreed that due to ABAs they were able to know peers' views on different aspects of the subjects. Since there were students from different schools and different subject streams they were able to do so.

A majority of (90%) students have agreed that their motivation to learn has been increased due to ABAs. But 10% responded to 'cannot say'. It seems that some students were not motivated by ABAs. According to lecturers they might have not participated in ABAs actively.

Almost 95% students had agreed that they were able to get a high grade from ABAs than in written assignments. Focus group discussions also confirmed that idea (91%). Because they were able to get high marks for group activities than for individual written assignments.

Under problems related to ABAs most of the lecturers' (05) have mentioned that the majority of students have not been prepared well for the ABAs. At the assignment instructions book students were asked to refer some selected study sessions and come prepared with those. But they did not do that. Therefore, expected outcomes of the ABAs may not have been achieved fully. Further, they have stated that some students have not been engaged in group activities. Moreover, a considerable number of lecturers mentioned that some activities and marking schemes provided were not suitable to the task to some extent. According to them in some marking schemes there were no proper marks allocation among the activities. Moreover, according to them in some, there were no places to state the lecturer's name, centre, grades etc.

A considerable percentage of the students (69%) expressed the view that some students who did not participate actively in their groups got the same marks as the active participants. According to the students about 90% have stated that they were not given proper prior instructions in relation to ABAs. It seems that they were not satisfied with the instructions given in the assignment book. According to them instructions should be detailed.

As suggestions, a majority of lecturers stated that the faculty should give more detailed instructions in the assignment book, rather than just mentioning the sessions that they have to refer to. Further, they suggested that activities and marking schemes should be clearer and marks should be allocated in line with individual and group activities. It seems that they prefer to have more individual activities at the ABAs. Further, they mentioned that marking schemes should be more comprehensive including all aspects.

CONCLUSIONS/RECOMMENDATIONS

On the whole, it could be concluded that according to both lecturers and students' ABAs is a good mechanism for evaluating students' performance. But there were some problems. Therefore, the Faculty should take steps to enhance the ABAs. Especially, the activities should be formed to address all students. As far as possible, individual activities also should be included. Further, ABAs marking schemes should be more precise and comprehensive. Instructions for ABAs should be given to students in advance in an organized manner.

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A STUDY ON THE ACCOMMODATION STRATEGIES USED BY TEACHERS IN EDUCATING CHILDREN WITH VISUAL IMPAIRMENT IN A REGULAR CLASS ROOM

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INTRODUCTION

The concept of Inclusive Education is an emerging concept which allows children with special needs including Children with Visual Impairment (CVI) to learn together with their peers with the support from a special education teacher under the responsibility of the regular education teacher. For successful inclusion, it is important to have an effective intervention of regular education teachers and special education teachers. Hallahan and Kauffman (2006) highlighted the lack of competency and negative attitudes of regular education teachers, lack of collaborative consultation between the regular education teacher and the special education teacher and the lack of accommodation strategies used by regular education teachers as issues still persistent in the practice of inclusive education. However, even with these limitations, inclusive education is in practice in today's classrooms with CVI. Sahin and Yorek (2009) stated that different accommodation strategies should be used for CVI in order to successfully include them in the regular classroom. Price, Mayfield, Mac Fadden and Marsh (2000) highlighted that the terms such as accommodation and adaptation are being used in the literature in an interchangeable manner and the ultimate expectation of these terms are changing facilities, curriculum and teaching methods in order to facilitate learning of CVI. Therefore the main objective of this study was to examine whether teachers are using adaptation methods with CVI.

METHODOLOGY

The researcher selected the case study method for the study. Three primary classrooms from three schools coded as A, B and C as three cases from the Gampaha Educational Zone, in the Western Province were selected as the sample for the present study. A purposive sampling method was used to select the two classrooms at grade 5 and one class room at grade 2 where CVI were included. Three CVI and three regular education teachers and the special education teacher assigned to the selected schools were the respondents of this study. Data collection occurred over a period of three weeks with five visits in two consecutive periods to each of the classrooms. Observations and semi structured interviews were used as the main means of collecting data in line with the following objectives.

- To examine the extent of the use of accommodation strategies by regular education teachers with the CVI
- To investigate the nature of support provided by the special education teacher in using accommodation strategies and
- To examine the views and experiences of regular and special education teachers in facilitating CVI in regular classroom

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LESSONS LEARNT

The study revealed that the extent of the use of accommodation strategies by regular education teachers with the CVI varied according to schools as follows.

Table 1– Accommodation strategies used by teachers

Item No.	Strategy	Class teacher of school A	Class teacher of school B	Class teacher of school C
1	Physical space of the class room (facilitate to the mobility)	Not at all	Not at all	Most of time
2	Seating arrangement (Facilitate academic and social development)	Not at all (Seated separately from the peers)	Most of times (seated with peers)	Not at all (Due to mothers' presence)
3	Appointing a buddy (Facilitate academic and social development)	Some times (one buddy)	Most of time (more buddies)	Not at all (a buddy was not appointed)
4	Clearly explain the visual based material	Not at all	Most of time	Not at all
5	Collaborative learning	Not at all	Most of time	Not at all
6	Verbal assessment method	Some times	Most of times	Not at all
7	Brailed question papers	Not at all	Not at all	Not at all
8	Tactile teaching aids	Not at all	Some times	Not at all
9	Questioning	Some times	Most of times	Not at all
10	Extra time to completion of task	Not at all	Not at all	Not at all
11	Instruction through real world experiences	Not at all	Some time	Not at all

The data in the table 1 revealed that the class teacher of school A used only three strategies (item no. 3,6 & 9) at a moderate level but the rest of the strategies (Items no. 1,2,4,5,7,8,10,11,) were not used by the teacher to facilitate the CVI. The class teacher of school C did not use any strategy except item no.1 to facilitate the CVI. However the class teacher of school B used six strategies (Items no. 2, 3, 4, 5, 6, and 9) at a higher level and item no. 8 and 11 were at a moderate level. It can be highlighted that class teacher of school B used more strategies to accommodate the CVI than the rest. It can be interpreted that the reasons for less use of accommodation strategies were lack of professional knowledge, poor communication between the special education teacher and the regular education teacher, and practical difficulties in relation to regular education practice with negative views of teachers towards educating CVI.

The support of the special education teacher was inadequate to facilitate the CVI because of lack of special education teachers in the field and lack of a monitoring process. Even though the special education teacher was supposed to act in an advisory capacity to adapt the teaching

learning process according to students' needs, the support was narrowed down to teaching Braille only. It was found that CVI are taught Braille by tuition arranged by the special education teacher.

The views and experiences of regular class room teachers on facilitating learning of CVI were different. It can be highlighted that the support from the special education teacher to use accommodation strategies was not adequate.

Class teacher school A stated that,

“He is the only one special education teacher for this zone and therefore he is so busy. On the other hand I am also so busy with my work and I don't have time to consult him”

But the class teacher of school C said,

“he just comes once a week and stays little while with child and just go” .

It was revealed that the support from the special education teacher was inadequate because of the busy work schedule of both parties and the lack of a monitoring system at school and the zonal level. It was found that none of the teachers had received any in-service training on inclusive education. The class teacher of school A and B used these strategies through experience by interacting with the particular child. For example the class teacher of school A stated that,

“Actually I'm not trained regarding teaching these types of children. I teach this child through experiences being with him”

But the class teacher of school C had not used any accommodation strategy to facilitate learning of CVI.

It was found that through the views of teachers, the level of commitment toward the CVI was basically based on the views of teachers and the performance of the child. Except the class teacher of school B the other teachers held negative views on accommodating CVI in the regular class room setup.

Some stated that the regular school practice; the teaching learning process and specially assessment process are not suitable for the CVI. Given these conditions, all the respondents stated that they are having some problems related to the regular education setup when using accommodation strategies for CVI such as problems in covering the syllabus, large class size, fulfilling the needs of school and parents and lack of professional support and expertise.

It was found that the main concern of the special education teacher was teaching Braille only and nothing else.

“My main responsibility is teaching Braille. If I go to consult teachers sometimes they will misunderstand me. Therefore I don't like to give them advices”

According to the above statement, the special education teacher himself was not aware about the support that should be given to the regular education teacher to adapt the teaching learning process. However the support should be provided not only with teaching Braille but also with the use of the other accommodation strategies specially making teaching learning aids and assessment process according to the needs of CVI. It can be highlighted through the views and experiences of the special education teacher, that lack staff who have specific knowledge on accommodating children with special needs; busy work schedule and poor recognition related to children with special needs and their teachers in schools were the main barriers in accommodating CVI in regular classroom.

CONCLUSION AND SUGGESTIONS

It can be concluded that even though the concept of inclusive education helps to eliminate the social discrimination against children with Visual Impairment, in practice they are isolated again in the regular class room basically due to poor usage of accommodation strategies. This situation arises due to lack of professional knowledge of regular education teachers, lack of communication between regular education teachers and the special education teacher, the views of the regular education teachers towards education children with Visual Impairment and the difficulties related to regular education practice.

The final outcomes of this research would provide a basis for developing pre-service and in-service training programmes on inclusive education training special education teachers to facilitate the CVI in regular classrooms, to establish a proper monitoring system at zonal level. Finally it is important to arrange a particular time and space at the school to maintain a rapport between the special education teacher and the regular education teachers in order to provide an effective education for Children with Visual Impairment.

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ORGANIZATION OF THE INSTRUCTIONAL SUPERVISION PROCESS IN THE SCHOOLS

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INTRODUCTION

Since independence the quantitative expansion of the general education system in Sri Lanka has progressed satisfactorily. However, the quality of education has not been improved in parallel with such quantitative expansions. With this background, ensuring the quality of education has now become an urgent educational priority and is a key challenge of our general education system. On the other hand the instructional supervision process has become a very important aspect to ensure effectiveness & efficiency of teaching- learning process in the school and finally to secure the quality of education. Therefore it is very important to ensure and establish an efficient instructional supervision process in the schools. This research study focused on the organization of the instructional supervision process of schools.

According to Glickman (1992), “without a strong, effective, and adequately staffed program of supervision, an effective school is unlikely to result” Supervision can be defined as “the glue of a successful school” (Glickman, Gordon, & Ross-Gordon, 2007). Sergiovanni and Starratt (2002:6) describe instructional supervision as opportunities provided to teachers for developing their capacities towards contributing to students’ academic success. Therefore maintaining an effective instructional supervision process is one of the most important functions of the school. The effectiveness of the instructional supervision process depends on an adequately organized instructional supervision process.

Teaching-Learning process is the most important aspect in our classroom. However, research shows that many teachers in our schools are unprepared to meet the needs of different learners or to manage their classrooms. Many teachers are not aware of how to develop an effective lesson plan, how to write specific, observable and measurable learning objectives and how to create or maintain an effective learning environment for their students. The other issue is that many principals in our schools are unprepared to supervise, monitor or manage the performance of teachers. The effectiveness of teachers and the learning environment they create are directly within the control of the principals. However, many principals who are willing to move to impoverished areas lack the necessary supervisory and management skills. As a result, those principals fail to ensure that their teachers direct students towards success. So the education system in our country should pay greater attention to instructional supervision more than ever before. Therefore the instructional supervision process occupies a unique place in the entire school system. Accordingly, this study focused on the organization of the instructional supervision process in the schools.

The following specific research questions were formulated in line with the main objective of the research study.

1. What is the nature of the organizational structure of instructional supervision process in the schools? On the basis of principals views.
2. What is the degree of functions and responsibilities of vice principals, sectional heads and subject heads in the instructional supervision process?

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3. What are the problems and challenges faced by supervisors involved in the instructional supervision process?

METHODOLOGY

The survey research design and the descriptive research approach were selected for the conducted of this study. The study used qualitative and quantitative techniques for data collection which included questionnaires and interviews. Simple statistical methods were used for data analysis. The population of this study consisted of all (46) the 1AB, 1C, Type ii & Type iii schools in the Dehiattakandiya Educational Zone of Ampara District. Accordingly, 10 schools were selected in order to maintain a meaningful representation of the school population. Thus the total sample included 10 Principals, 18 Vice-principals, 28 sectional heads, 24 subject heads.

RESULTS AND DISCUSSION

1. The organization of instructional supervision process in the schools.

Table 1-Organization of instructional supervision by principals.

	Statement	Always happening	%	Moderately happening	%	Not happening	%	Total	%
01	Assign a supervisory team for instructional supervision process.	04	30	03	30	03	30	10	100
02	Consider education qualifications and seniority to select supervisors.	07	70	0	0	03	30	10	100
03	Consider respective circular (2003/38) to select supervisors.	02	20	04	40	04	40	10	100
04	Use instructional supervision work plan.	07	70	03	30	0	0	10	100
05	Allocation of time for supervision from the school time table.	04	40	03	30	03	30	10	100
06	Maintain supervision reports.	05	50	02	20	03	30	10	100
07	Use instructional supervision reports to improve teacher professional development.	03	30	03	30	03	30	10	100
08	Facilitate to training supervisors.	05	50	03	30	03	30	10	100

According to Table 1, nearly 60% of the principals had developed a systematic mechanism to improve of instructional supervision process of their schools. Specially, it was very important to assign a supervisory team for instructional supervision. Majority (70%) of the principals had considered education qualifications and seniority to select supervisors and used an instructional supervision work plan. However, nearly 40% of the principals had not given sufficient consideration to developing a proper mechanism to improve instructional supervision process of their schools. In the interview they pointed out that due to lack of staff and experienced senior teachers they were unable to assign a supervisory team for instructional supervision process.

2. Functions and responsibilities of instructional supervision process.(views of vice principals, sectional heads and subject heads)

The majority (60%) of the vice principals mentioned that they always give their support to plan, organize, supervise and maintain the school instructional supervision process and perform their duties. Nearly 50% of the sectional heads and subject heads mentioned that they always give their support to organize school based projects for teacher development, supervise co-curricular activities, maintain and evaluate monthly supervision reports, class room observation, resolving issues of teachers, maintaining sectional data bank, monitoring and evaluation of term notes, time table, lesson notes etc.

3. The problems and challenges faced by supervisors in the school instructional supervision process.

Majority (80%) of the supervisors mentioned that, lack of experienced and competent supervisors, lack of time for supervision due to bulk of administrative and other management duties, negative attitudes concerning supervision of teachers, lack of pedagogical knowledge concerning instructional supervision, deficiencies of formal training of supervisors, & inconvenience for establishing sound supervisory culture in their schools as the main issues and challenges faced by them in the instructional supervision process of the school.

CONCLUSIONS/RECOMMENDATIONS

Educational activities in schools should be supervised to achieve the education objectives. Hence instructional supervision process is a good mechanism to up-grade performance of the teaching-learning process and teachers up to required levels. It can be concluded that the efficiency of the teaching- learning process of the classroom and professional development of teachers would be unsuccessful and expected goals would not be achieved, if the internal supervision process of the classroom is ignored. Majority of principals have developed a proper organizational structure to establish and maintain instructional supervision process of their schools. It can be concluded that, all the vice principals, sectional heads, and subject heads had given their fullest support to plan, organize and maintain the school instructional supervision process and performed their duties and responsibilities well. It can be concluded that, lack of experienced & competent supervisors, negative attitudes towards supervision among teachers, lack of pedagogical knowledge concerning instructional supervision, deficiencies of formal training of supervisors, lack of time for supervision are main obstacles & issues faced by them. Accordingly, some recommendations can be made as follows.

1. Priority should be given to the school instructional supervision process & it should be carried out continuously. Principals should be serious about the instructional supervision and establishing of a sound supervisory system in the school.
2. The school principals should be used to effective and meaningful recruitment procedures for the selection of school supervisors. Specially, the respective circular (2003/38) issued by the ministry of Education to select supervisors must be considered.
3. All the supervisory staff must be constantly refreshed on quality & appropriate supervision training.
4. All the supervisory staff must be maintained and trained to use instructional supervision reports to improve teaching-learning process and teacher professional development.
5. All the supervisory staff must develop optimistic attitudes towards supervision among teachers.
6. Establishment of a sufficient school climate that is conducive to effective instructional supervision process.

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AUTOMATED WATER MANAGEMENT IN RICE FIELDS

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INTRODUCTION

Oryza Sativa Indica, commonly known as Indian rice is a plant species which produces the cereal consumed by almost one third of the world's population as their staple food (Abdullah *et al.*, 2006). This sub species of rice is a seasonal plant which requires a huge amount of water and is usually grown in submerged fields for the major part of its life span. Therefore, it is of highest importance to have a reliable irrigation system and a specialized field in rice cultivation. In the special design of fields for rice cultivation, in order to retain the water, rice fields are separated into a set of plots and these plots are under-layered with mud. The water supply system takes a cascaded form so that the water flows to the lower level plots through the upper level plots and heavily utilizes the flow due to gravity. At the same time, the water in the rice fields has a tendency to dry up due to excessive sunlight or even due to being absorbed partially by the field floor itself. Therefore, the farmer is burdened with a responsibility to constantly monitor and refill the water up to the adequate levels by restructuring the plot walls' openings.

Meanwhile, in Sri Lanka too rice farming has been a main part of agriculture. To cater for its ever growing population's demand, the fast and efficient production methods have been preferred. Use of fertilizer, chemicals as insecticides and pesticides and also the use of genetically engineered rice varieties have been some of these techniques. Though this intensified agriculture increases the yield, it brings adverse effects too. Increased rate of cancer and kidney failures have been visible in areas where rice cultivation is done on a large scale. To minimize these adverse effects, recently, considerable interest is centered on the traditional methods of rice cultivation. These methods heavily rely on weather patterns as well as on varieties of rice which are immune to most of the insect attacks. Still, these varieties of traditional rice produce a reduced yield. It is a great challenge to meet a high yield while cultivating the traditional rice varieties with eco friendly methods. Precision agriculture (PA) (Zhang *et al.*, 2002) is a handy technique where the right amount of resources is supplied at the right time in the right amount, to meet this tradeoff. In deploying the PA concept in rice fields, to supply the most important commodity, water, the farmer is overburdened with tight monitoring and control requirements. Although many electronic resource management systems for rice farming are available (Tran and Nguyen, 2006), none of them address controlling of water.

In this paper an electronic water management system is proposed with a remote management feature. This will provide a means of managing the water in rice fields in an efficient manner so that the high yield is retained even when the eco-friendly traditional methods and rice varieties are used. Moreover, this novel system greatly reduces the workload of the farmer and releases the requirement for him to be at the field for water management.

METHODOLOGY

The proposed water management system consists of two main parts, namely a wireless sensor network to monitor the water levels over the rice field and a solenoid operated gate valve array based water supply system to manage the water flow to the field's plots (Figure 1).

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The water from a stream is stored in a reservoir from which the water is distributed to each and every plot in the field via polyvinylchloride (PVC) pipes using the gravitational natural flow. To have a better control of water flow, unlike in traditional rice fields, the plots are completely separated from other plots so that there is no water flow in between the plots. For the controlling of the flow of water to the plots, a set of gate valves are fixed in between the reservoir's outlet and the PVC pipes. This solenoid based gate valve array is controlled by a central electronic control circuit. Apart from these, the system is equipped with a remote control mechanism with the use of a global system for mobile communication (GSM) link which operates on a short message service (SMS) framework.

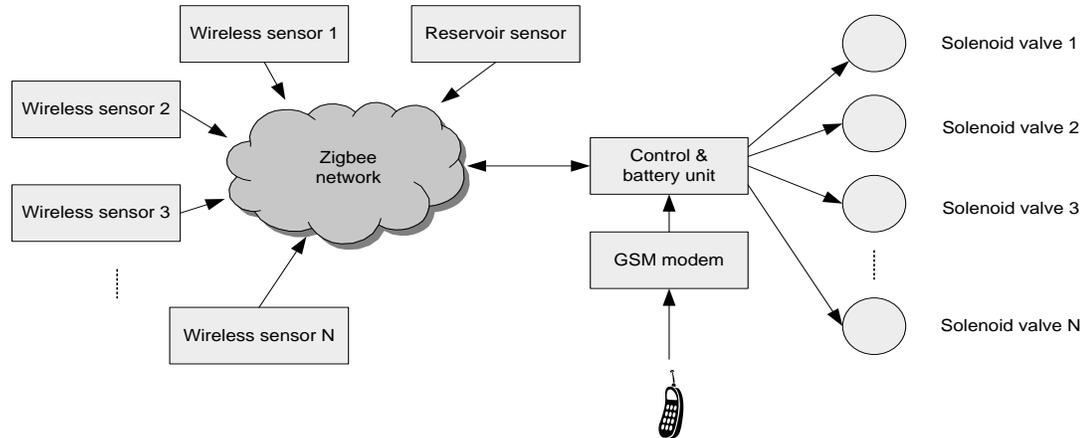


Figure 1: Block diagram of the proposed system

The basic building block of the sensor network, a sensor node, consists of a pair of electrodes which conducts a current upon contacting with moisture. This in turn produces a voltage at the output of the sensor circuit which is proportional to the amount of moisture in soil and once submerged in water it would provide a maximum current conduction. Depending on the seasonal requirement, the electrodes can be buried inside the soil or can be kept submerged in the water for detecting the moisture in soil/water (in the submerged field). Upon identification of the status of moisture in soil or water in the submerged plot, the same information is packetized with a unique packet identity and transmitted over a Zigbee network (Safaric & Malric, 2006). Each plot is equipped with a single sensor node while one sensor node is dedicated for monitoring the reservoir water level status. Note that this sensor node hardware including a solar panel to generate the required power is fixed to a plastic peg which can be generating the level crossing message. mounted accordingly so that the electrodes are placed at the needed measuring level (Figure 2) Further to this, as the wireless sensor network operates using a battery charged by solar power, it is seriously power constrained. Therefore, the sensor nodes transmit their information only upon required, saving power. Once a set threshold level crossing is detected, the node wakes up and generates a message with its node identification tag.

To avoid the level bouncing due to the ripples on the water surface, after a level crossing is detected a timer is started and the timer periodically checks for the level within next 15 minutes before.

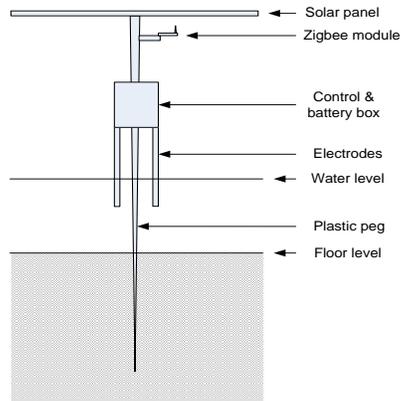


Figure 2: wireless sensor node

The message is relayed through the Zigbee based wireless sensor network. Upon receipt of this “low water level” message at the central control node, the control circuit interprets the message and checks for the availability of water in the reservoir and then activates the respective solenoid to release the water. During this control process, the central control unit stores the status of different plots’ water levels, reservoir water level status as well as gate valve open/close status in a local database.

The employed SIMCOM203000 GSM modem (Texas Instruments, 2012) accepts SMS messages from the farmer’s mobile and can return a list containing the water level status and the gate valve status through SMS. Furthermore, upon opening a certain gate valve, system starts a counter and either upon the expiration of the timer in 15 minutes or upon detecting a level crossing, the corresponding valves are closed. If the timer expired without a crossing detected, it generates an error message SMS and forward the same to the farmer. On the other hand the farmer can command the control circuit to issue open/close a certain solenoid forcefully by an inward SMS.

TEST RESULTS AND DISCUSSION

To verify the accuracy of monitoring the moisture content in the field, the voltages generated at the output of the sensor was investigated and it clearly shows a linear behavior (Figure 3).

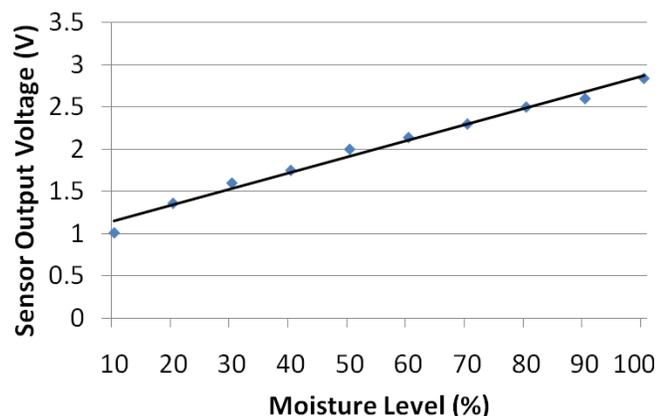


Figure 3: Moisture sensor performance

In order to verify the consistency of water management, a prototype system was deployed in one plot of a two plot rice field. In this test, two nearly identical $3m \times 4m$ plots were selected from a real rice field. Sensor electrodes were placed just touching the wet floor and the threshold was set

to 90%. The system was operated for 24 hours on a non-raining day and the other plot was not controlled. The moisture level readings were recorded as in Table 1.

It clearly shows that the implementation of the proposed water management system has maintained the moisture/water level in the rice fields.

CONCLUSIONS AND FUTURE WORK

A novel water management system has been proposed to manage and maintain the water levels in rice fields automatically. The remote management feature provides the farmer the ability to monitor the water management process from a remote location. This is a very handy system for a busy farmer managing multiple rice fields at different locations.

Table 1: Soil moisture level

Time (hrs)		00.00	01.00	02.00	03.00	04.00	05.00	06.00	07.00	08.00	09.00	10.00	11.00
Moisture Level (%)	Without the system	100	100	100	100	100	100	100	100	100	100	90	90
	With the system	100	100	100	100	100	100	100	100	100	100	90	100

Time		12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00
Moisture Level (%)	Without the system	80	80	70	60	60	60	60	60	60	60	60	60
	With the system	100	90	100	100	100	100	100	100	100	100	100	100

The proposed system is estimated to be incurring a capital cost of Rs.30,000 per acre on average where the operational cost is almost negligible. With the objective of eco-friendly rice cultivation retaining the high yield, this cost can be well justified.

This system does not facilitate a complete remote control. By introducing a set of sluice gates the water drain system can be altered so that the water level can even be reduced remotely. This would be a preferred feature to handle the excess amounts of water filled due to rain. Further, this system conveys the information with only a binary resolution as it conveys only whether the water/moisture level is above or below a certain reference threshold. However, if a sensor node can capture and convey more information such as the absolute water level, it would be very beneficial.

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AUTOMATED DOMESTIC WATER PUMP CONTROL SYSTEM WITH ENHANCED USABILITY AND LOW MAINTENANCE

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INTRODUCTION

Water is the most essential commodity for human life. Even though two third of the earth's surface is covered by water, less than 1% of that can be utilized for our day to day needs which comes from a variety of sources (Postel, 1996); the wells, lakes, rivers, rain water collections as well as purified sea water are these sources. In any of these forms, the water is very precious and should be used very carefully.

In Sri Lanka, for domestic use, the water is usually pumped to an overhead tank either from a well or from a sump which collects water from the National Water Supply and Drainage Board (NWS&DB) water supplies. The water is pumped from the well to the overhead tank using a domestic water pump which may run just under 1kW. From the tank, the water flows to the tap openings due to the force of gravity. The water pumps are usually manually switched on and off which requires a considerable human involvement in this process. Human errors such as forgetting to switch off will result in overfilling the tank. This in turn results in wasting both the electricity utilized to operate the pump and water itself. On the other hand, the water in the tank may be gradually utilized and it can lead to a situation that the tank runs out of water without being noticed.

To address these issues, many automatic water pump control systems have been proposed and implemented. The operation of these systems relies on a mechanism to detect the water level crossing the predefined thresholds. In order to detect the threshold some systems deploy a pair of electrodes at the lower and upper water levels (Rajapakshe, 2011). On the other hand some systems use float switches or vacuumed balls to detect the lower and upper level crossings (REUK, 2008 and Siben, 2005). However in all these systems, two clear drawbacks are visible. With time, the electrodes or the float switches which are in touch with water will get corroded or clogged with minerals in the water. Eventually they start malfunctioning and need maintenance. On the other hand, the deployment of the existing systems requires considerable technical expertise. Especially, deploying a sensor at the bottom of the well to detect the well's low threshold water level needs considerable effort.

In order to overcome these drawbacks in the existing water pump control systems, in this paper, a novel automatic water pump control system is proposed. In this system the innovative design step is to use an ultrasonic water level sensor (Robot Electronics, 2012) which does not need to be in contact with water and also can be installed away from the water surface at an easily accessible location at the top of the tank/well. Further, the proposed system is in a modular form. The latter feature makes sure that even a user without any technical background would be able to install this system. Furthermore, the installation can be completed in a very short time.

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METHODOLOGY

The proposed system consists of two sub units namely a wireless sensor node and a pump control unit (Figure 1). Sensor node is equipped with an ultrasonic module which emits an ultrasonic beam and collects the reflected beam from the water surface. Then it calculates the distance to the water surface. Furthermore, the sensor node consists of a Zigbee transceiver module (Safaric, 2006) to transfer the water level information to a separate control unit. This same sensor node is powered by a 9V battery, hence at the sensor, power is a scarce resource. In order to save power, the node is normally in sleep mode. In a practical implementation, the sensor node is mounted to a wall near the top of the tank/well and there are two such sensor node units employed to monitor the water levels in the tank and the well. The current water levels in the tank and the well are represented by S1 and S2 respectively.

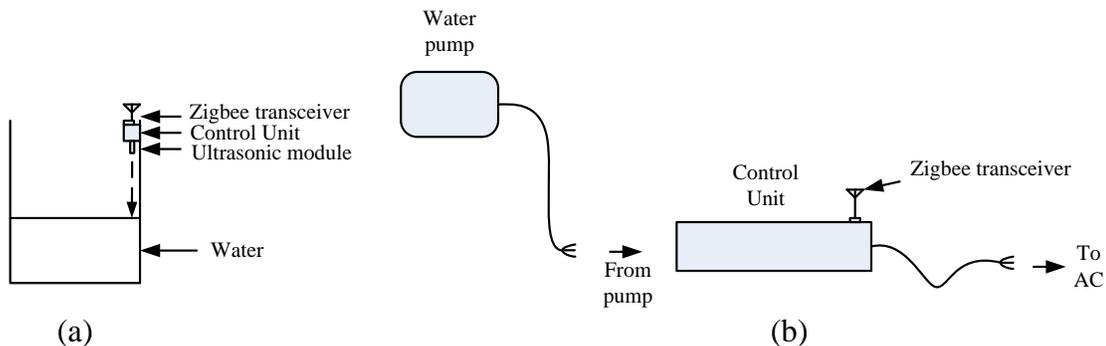


Figure 1: (a) Sensor node deployment (b) Pump control unit deployment

There are two important water threshold levels namely the low (L) and high (H) levels, crossing of which will initiate a notification message generation. Upon the generation of the notification, the transceiver sub unit wakes up and transmit the information to the remote control unit. At the sensor node, all these processes are controlled by a PIC 16F877 microcontroller based sensor control circuit. The control unit too consists of a Zigbee transceiver which receives the water level information transmitted from the two sensor nodes and act according to the water control algorithm shown in Figure 2.

Note that in order to improve the user friendliness in the system, this pump control unit has a socket to which the water pump's power plug can be plugged and a plug which is to be connected to the AC 230V power supply. Eventually the pump is powered through the control unit (Figure 1 (b)). The control unit is equipped with a silicon control rectifier (SCR) based electronic switch (Bogart, 2004) which can on/off the power supplied to the pump. Another important feature of this control unit is that an inbuilt transformer-rectifier-regulator circuit to provide a 5V direct current supply for the internal circuits including a PIC 16F877 microcontroller and for the Zigbee module.

TEST RESULTS AND DISCUSSION

In order to verify the proposed pump control system's operation, a test setup was installed in a commercial plastic water tank of 1m height and with a well. The water inlet in the well was so placed so that the water level in the well does not fall below the minimum during the water filling process. Further, the lower level and the upper level in the tank were selected to be 10cm and 90cm respectively. The system was run for 10 tests and the results are shown in Figure 3 which clearly demonstrates the accuracy of filling. The use of a novel technique, the ultrasonic based water level measuring, provides usability and robustness, the system has a very good accuracy in

starting/stopping the pump. The minor variations are the results of ripples in the water surface which are not captured by a ripple rejection feature in our control algorithm.

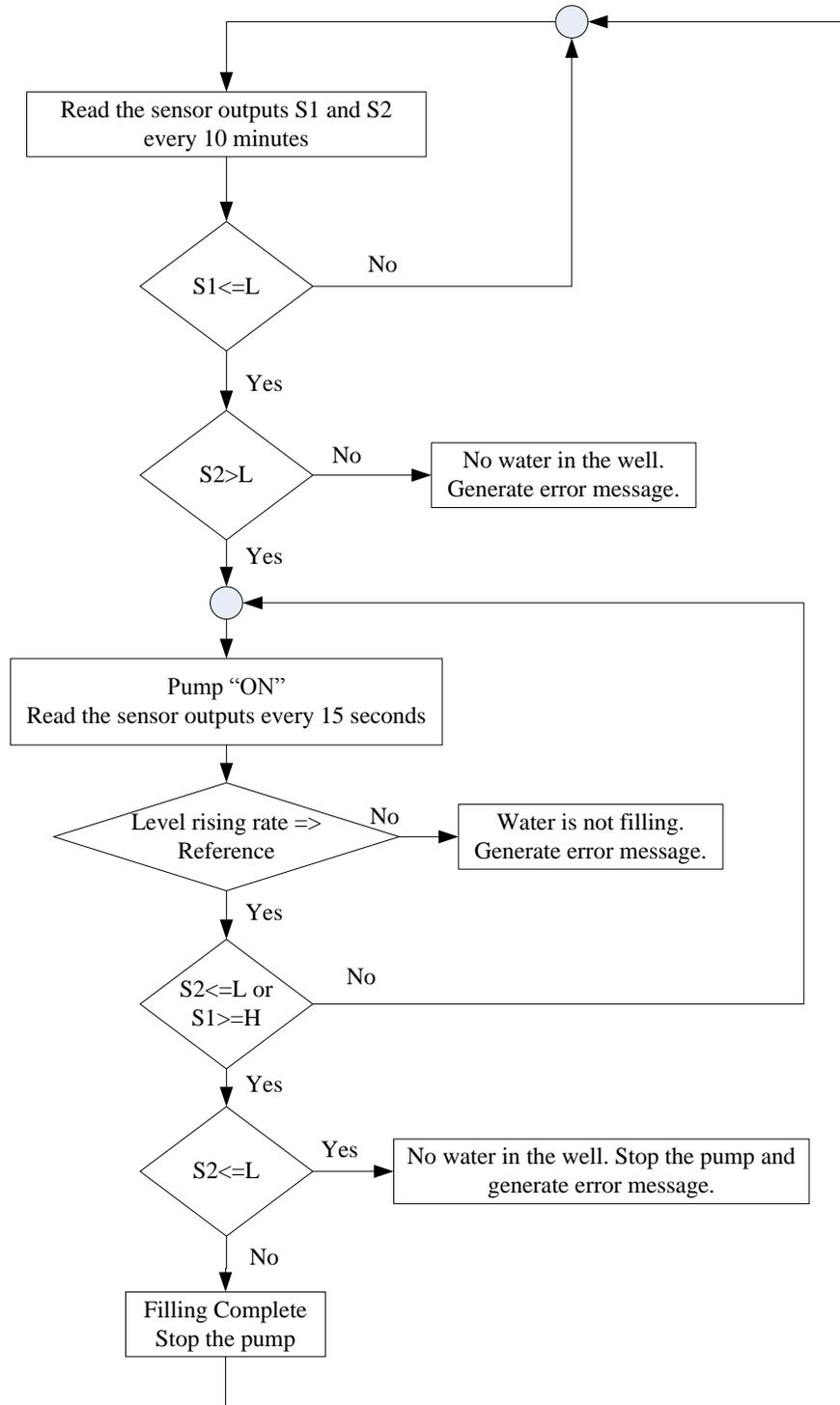


Figure 2: Water management algorithm

CONCLUSIONS AND FUTURE WORK

This paper discusses the design of a control system for a domestic water pump. The system is designed and developed in a modular form such that the installation is very simple and can be carried out even by a non-professional. Further with the use of ultrasonic water level sensors, the malfunctioning of sensors with time is minimized.

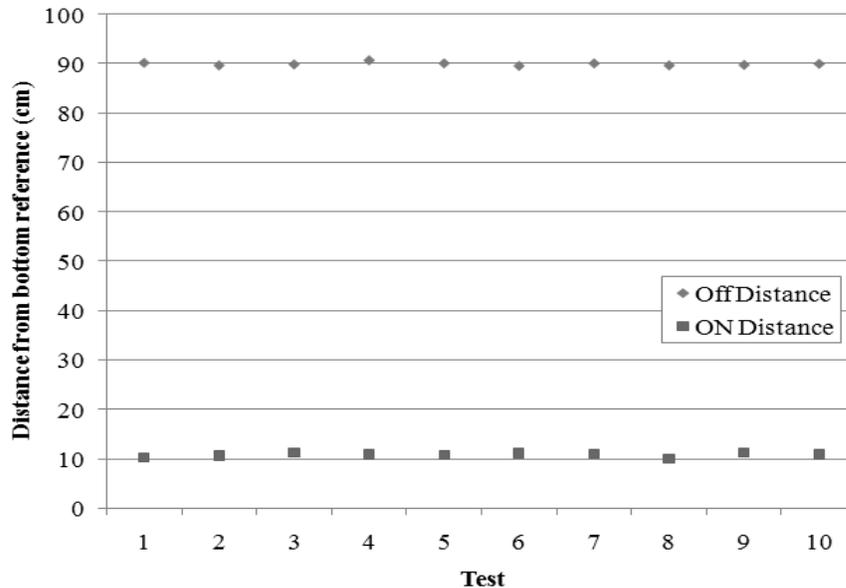


Figure 3: Accuracy of water filling

This system can be further improved by accompanying a SMS notification feature which will inform the owner in case of an error. On the other hand the sensors are strictly power limited; hence improving the sensor's power utilization with a better sleep-wake up mechanism would be very handy.

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DESIGN OF A REMOTE CONTROLLED LIQUID MEDICINE DISPENSER

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INTRODUCTION

State funded free health facilities are of immense value to many Sri Lankans. Rich or poor, these quality health facilities have saved many lives over the past. Well qualified doctors, trained nursing staff as well as adequate and timely supply of drugs have been the key ingredients in maintaining these standards.

However, it is a well accepted fact that Sri Lanka is recently experiencing a severe shortage of professionals such as doctors and nurses (De Silva, *et al.*, 2010). With the increasing population and also with the increasing medical requirements, this problem has grown to a non-negligible situation. Without adequate nursing staff, treating the patients and dispensing medicine on time have started to deteriorate from the maintained standards.

In order to address this issue, this paper presents a remote controlled liquid medicine dispenser, which will enable the doctor or the nurse to remotely order the required amount of liquid medicine to be dispensed to each and every patient via a global system for mobile communication (GSM) network's short message service (SMS) framework. The remote control feature available here which is novel to automatic medicine dispensers would make the proposed system superior to many other automated liquid medicine dispensing systems available today (Borel, 1995 & Lee, 1992 & Klibanov, 2003).

The system's characteristics allow the nurse to store the generated short messages and re-issue them as required, which will relieve the nurse's workload. Consequently, a single nurse would be able to dispense liquid medicines for many patients in a lesser time. Moreover, the same system can be deployed for multiple liquid medicine types and in multiple applications; either to inject medication intravascular or to dispense orally taken liquid medicine to a cup.

DESIGN METHODOLOGY

The proposed liquid medicine dispensing system consists of a mechanical arrangement to which a syringe can be fixed, a GSM modem for receiving the short message and also a control circuit to control the overall operation (Figure 1). The nurse can send a short message to the GSM modem using the predefined message format (Figure 2) and upon the reception of the short message at the GSM modem, the message is forwarded to the control unit. PIC 16F877 microcontroller based control unit then checks for the message validity and extract the dispensing volume and rate information from the message.

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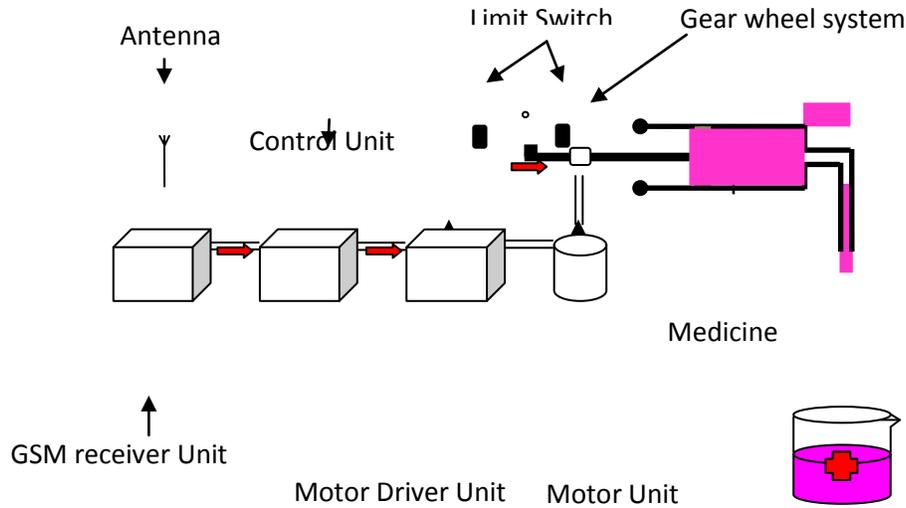


Figure 1: Block Diagramme of the Proposed system

A calculation is carried out according to (1) and the motor driver unit rotates the stepper motor in the calculated speed and the calculated number of turns. This in turn dispenses the requested amount of liquid medicine in the requested rate. Note that the motor speed is constant, hence in order to control the dispense rate the rotations are carried out in discrete time intervals as shown in figure 3. By adjusting the time interval between adjacent dispense times, the dispense rate is varied.

Validation code	Volume in ml with 2 decimal points	Rate in ml/h with 2 decimal points
XXXX	VVVVV	RRRRR

Figure 2: Short message structure

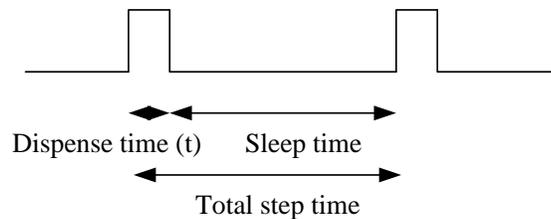


Figure 3: Dispense timing diagram

As shown in figure 4, with the motor rotations, a gear wheel system with a unit gear ratio transfers the rotations to a screwed shaft. A screwed barrel arrangement, through which the shaft passes, is linearly moved with shaft rotations. This linear movement is harnessed to move the syringe piston.

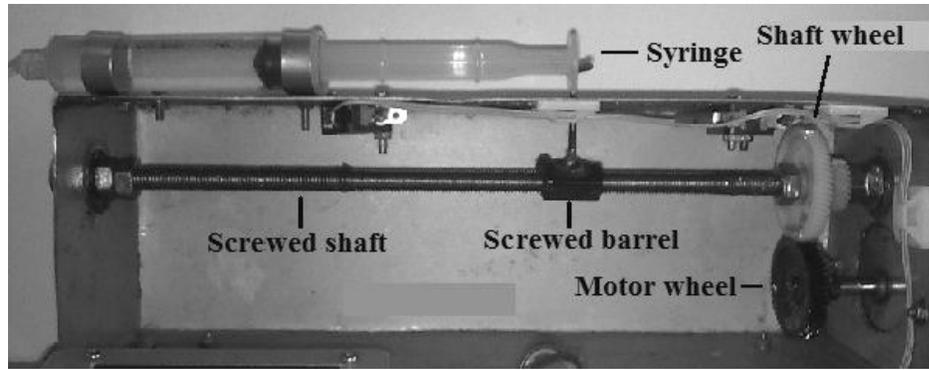


Figure 4: Mechanical unit of the proposed medicine dispenser

Let V volume is to be dispensed in R rate and a single step of the stepper motor dispenses v volume of liquid medicine. Then we need $\frac{V}{v}$ steps of rotation.

The total dispense time is $T = \frac{V}{R}$ and the step time is $\frac{v}{R}$. With a dispense time t , sleep time is,

$$\frac{v}{R} - t. \dots\dots\dots(1)$$

The constants v and t are to be obtained via trial tests for initial calibration.

Another added feature of this system is the ability to rotate the motor in the reverse direction such that the screwed barrel arrangement will move in the reverse direction which allows freeing the syringe from the system for cleaning and refilling.

RESULTS AND DISCUSSION

A prototype of the proposed medicine dispenser was designed and implemented and the tests revealed the v to be **0.0035ml** and that the time t is negligibly small. Hence the sleep time can be assumed to be $\frac{v}{R}$. Further, a perfect and error free SMS framework was assumed which is a reasonable assumption in Sri Lankan mobile communication networks.

With this setup, the tests were carried out by short messaging different volumes and rates for medicine dispensing. The actual volume and the time spent for dispensing the same were recorded. The results shown in Table 1 clearly show the accuracy of medicine dispensing which is a key feature in this system. The maximum dispense volume error of 10% and a maximum dispense time error of 11.11% are within the acceptable error margins of most of the medicine dispensing requirements.

Although there no solid relationship between the errors in dispensed volume and the rate of dispense is seen, this system shows errors in dispensed volume less than 5% for the dispense rates below 60%.

Table 1: Comparison of the requested values and actually dispensed value

SMSed Values			Actual Values		Percentage Error (%)	
Rate (ml/H)	Volume (ml)	Corresponding Time (S)	Actual volume (ml)	Actual Time Taken (S)	In Volume	In Time
5	2	1440	2.04	1470	2	2.08
10	4	1440	4.05	1471	1.25	2.15
30	4	480	4.15	495	3.75	3.12
40	4	360	4.16	380	4	5.56
50	4	288	4.18	300	4.5	4.17
60	4	240	4.12	250	3	4.17
70	4	206	4.1	208	2.5	0.97
80	4	180	4.05	200	1.25	11.11
90	4	160	4.25	175	6.25	9.37
100	4	144	4.4	152	10	5.55
100	5	180	5.07	180	1.4	0
100	3	108	3.26	120	8.67	11.11
80	3	135	3.19	143	6.33	5.92
60	3	180	3.05	180	1.67	0
40	3	270	3.04	273	1.33	1.11
20	3	540	3.03	542	1	0.37
100	2	72	2.19	78	9.5	8.33
80	2	90	2	90	0	0

CONCLUSIONS AND FUTURE WORK

A remote medicine dispenser was proposed which is a handy tool to issue liquid medicine for a large number of patients in a short time. This is a very good solution for the shortage of trained nursing staff. This system can also be used to issue medicine from a far away location.

The same system can be further improved by incorporating a mechanism which allows the nurse or a doctor to query the available amount of medicine left in the syringe. Another possible feature is to detect the dispensed volume using a position sensor array fixed to the syringe's piston and to have a feedback message sent to the nurse confirming the dispensed volume. This would help the nurse to verify the functionality of the system. Furthermore, a software interface based short messaging system would further ease the nurse's job where a medicine dispensing can be automatically carried out with reference to a data base stored in a computer.

Further improvements in the system to limit the errors to a narrower margin would be an interesting research/design challenge.

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USE OF TECHNOLOGY TO IMPROVE SOCIAL COHESION

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INTRODUCTION

Linguistic pluralism lays the foundation for social cohesion, which is characterised by inclusivity, respect for all, dialogue between all members of society. Linguistic pluralism is just one of several strategies that are required for social cohesion. Therefore technology can be used to overcome the language barrier with speech technology. In Sri Lanka the Sinhalese, make up about 75% of the population [according to 2012 census].

Therefore a mostly Sri Lankan information source comes out in Sinhala Language. In Sri Lanka Tamils and Sinhalese people are living side by side so they can mostly understand other group's language when they listen even if they couldn't read it. Considering this fact, we decided to implement this system as a Sinhala text to speech web browser application. In this stage we are only concentrating on Sinhala language when considering time and project scope. But we could like to mention that a Tamil Text to Speech system is also necessary to improve social cohesion. There are some Tamil text to speech browser applications in the world but no other functioning Sinhala Text to speech browser application in Sri Lanka.

Also there are a considerable number of people who are either visually impaired or totally blind (285 million people are visually impaired worldwide: 39 million are blind and 246 have low vision). Such people find it difficult to benefit from the information sources widely available on the Internet. Western countries and other more technologically advanced countries have tried to remedy this situation by building screen readers that would read out a selected piece of text. However, there are no such portability systems capable of converting text written in Sinhalese language to voice through the web Browser. This project is an attempt to build an open source text-to-speech (TTS) system that will be widely available, platform independent and easy to use. The solution will be implemented as a browser plug-in making it usable by anybody who has access to a browser.

BACKGROUND OF THE PROJECT

The conversion of text to speech, i.e. the process of automatic generation of speech output from computer readable text, is called speech synthesis. TTS systems have been developed for many languages, with a majority of them working with the English language. Sinhalese is a language used by a very limited population of the world. There are only a few attempts that tried building TTS systems especially for Sinhalese language. Those that are implemented function as stand-alone applications that require the user to follow a complex installation procedure. In contrast, this is the first known documented work on a Web Based Sinhala TTS application that has been developed as a plug-in for the Mozilla Firefox Internet browser. This application uses Festival Framework Based Sinhala TTS System. The Festival Speech Synthesis System is an open source, stable and portable multilingual speech synthesis framework developed at the Center for Speech Technology Research (CSTR) of the University of Edinburgh. This framework is considered the

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most suitable for Sinhala language by the local research community involved in language processing.

METHODOLOGY

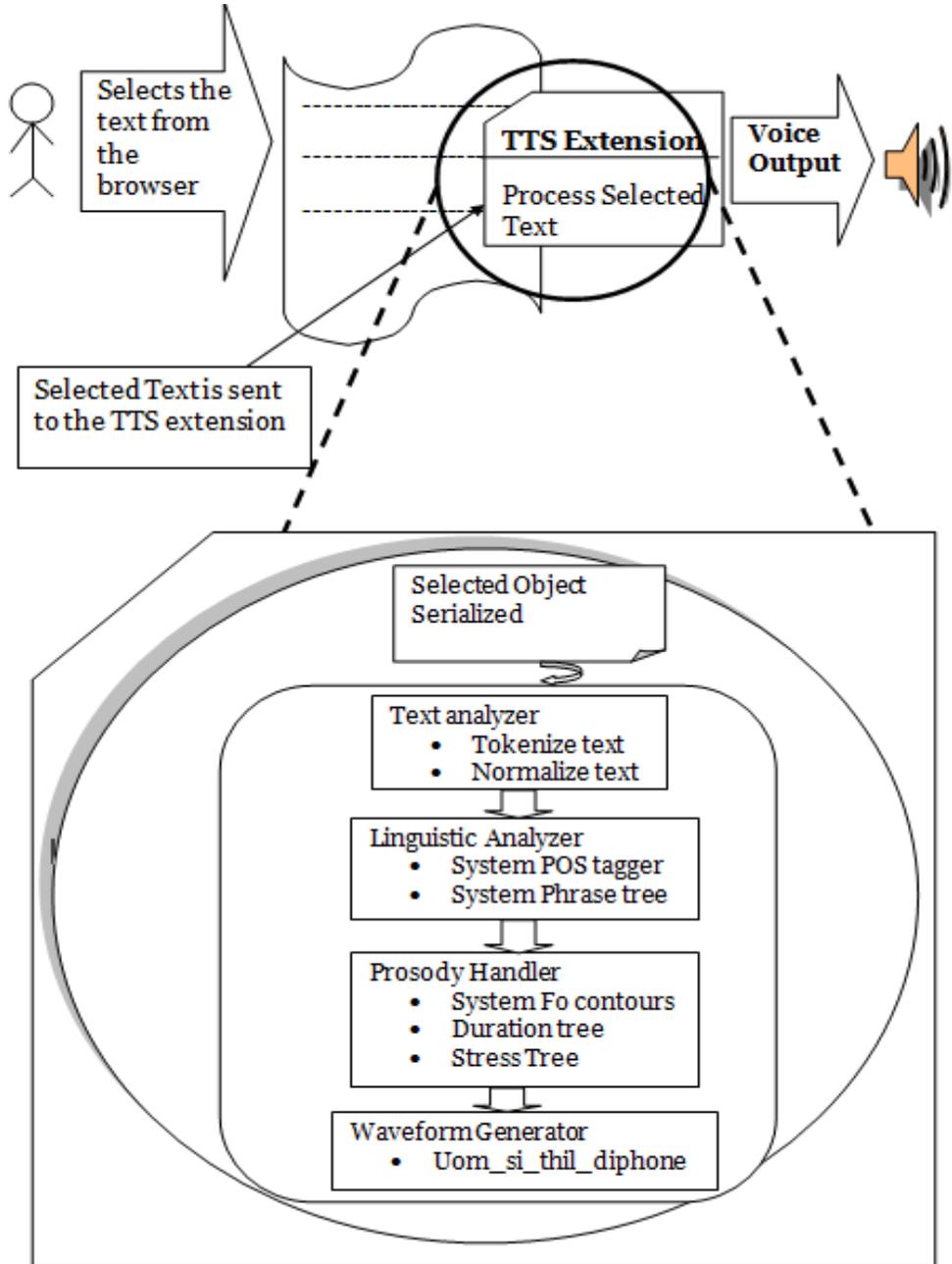


Figure 1 :Overall concept view of the system .

Figure 1 shows the overall system. The user selects the text to listen to from the browser and activates the extension. The extension converts the selected text to speech and plays the output on the computers speakers or other sound producing device. The core of the system consists of Sinhala TTS engine which will be used to generate speech synthesis for Sinhala, it takes phones dictionary from linguistic analyzer and normalised Sinhala Unicode text from text analysis as

input and match the letter to sound rules and letter to phone prediction which results in desired phone sequences. Then using the Unit Selection Algorithm, appropriate sound segments for the phone sequences are generated with the help of Speech Database. Finally the Waveform Synthesis mechanism outputs the sound relevant to the wordings. One of the major parts is the system designing a speech data base. When designing speech data base, prerecorded female voice is used for speech output.

DESCRIPTION OF TECHNOLOGIES USED

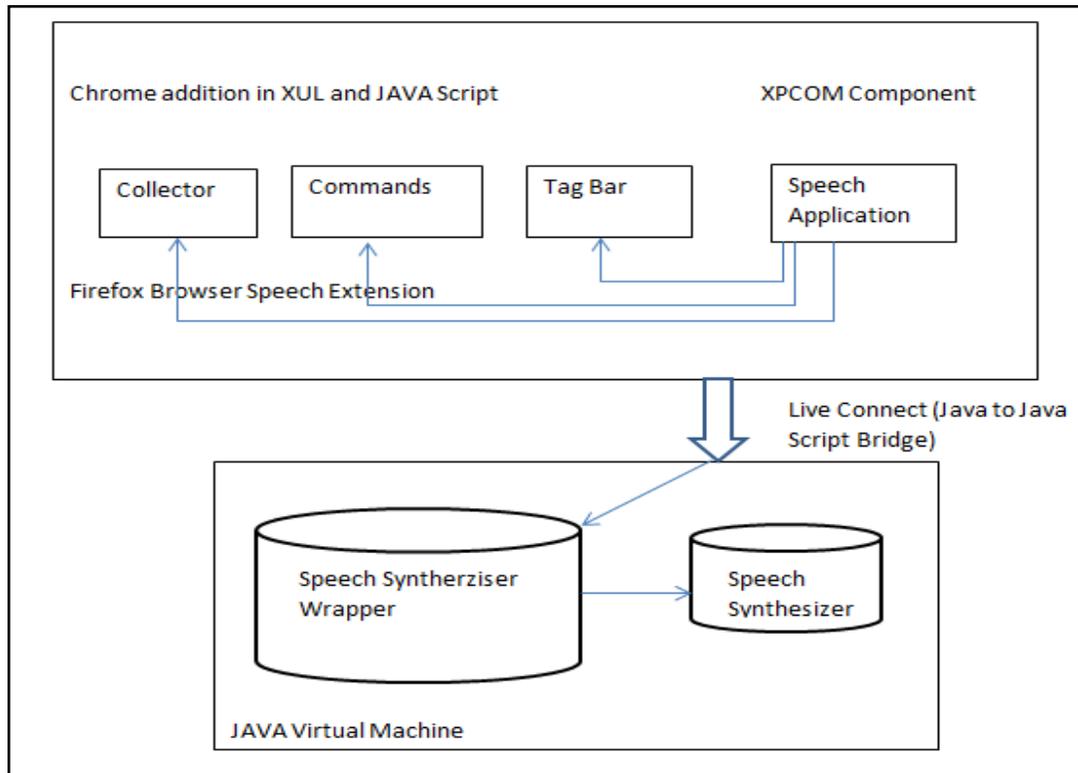


Figure2: Firefox Speech Extension Data Flow Diagram

Implementation and evaluation of the Sinhala TTS browser extension based on festival framework is described in this section. Two core components of the Java Speech API, i.e., speech recognition and speech synthesis have been used as the foundation. The Java platform is the best option to design a speech application given its portability, platform independence and support provided by all major web browsers. Other technologies used in this project include Live Connect, Speech Synthesizer, Chrome, and XPCOM (Cross Platform Component Object module). The Chrome Component located in the Browser extension is able to add features to the Browser and XUL files these are contained in the Chrome Component and helps to design extension's user interface. The XUL file in with the XUL file in the browser, hence the extension adds additional functionalities to the browser. XPCOM is a framework that allows different pieces of the software to be developed independently. It helps integrate JavaScript and the Java component of the software. Live Connect is a feature of Web browsers that allows Java and JavaScript software to intercommunicate within a Web page. From the Java side it allows an applet to invoke the embedded scripts of a page or to access the built-in JavaScript environment.

Conversely, from the JavaScript side, it allows a script to invoke applet methods, or to access the Java runtime libraries.

DISCUSSION AND FUTURE WORK

World Wide Web is gaining both revenue and popularity. The ease of using this application is one of the main concerns in today's technological world.

This system is a browser plug-in that can be installed on any browser supporting Java language. This system is attached to the browser as a plug-in and is currently used with the mouse interface. There are few limitations to this project, this application will not work with any other browser except with Firefox, due to the fact that Mozilla is an open source unlike remaining browser. Currently the application is implemented in Firefox. This application can be extended to other applications such as mobile browsers (Opera mini, Android Browser, [Dolphin Browser](#)). The project can also be further improved by incorporating voice commands thus maximising the usability of the system and also can be customised for fully blind people using keyboards short cut commands.

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NEW CONCEPT FOR ANGULAR POSITION MEASUREMENTS

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INTRODUCTION

Angular position sensing is an essential measurement in control system applications, various industrial applications and physical measurements. The three type of angular sensors available are capacitive, inductive and resistive. Due to non-contact moving behavior of rotary capacitors, capacitive sensors are more popular in position sensing.

Existing measuring methods in both capacitive and inductive sensors use alternating currents to obtain measurements. It requires oscillators to generate AC waves. As a result, measuring methods get complex, are high in cost and more difficult to use.

The purpose of this paper is to introduce a new concept for angular position measurements. This concept focuses on an innovative approach to capacitance measurements, where it can be used in position sensing.

As a replacement for AC currents in conventional systems, charging time of a capacitor under DC current is used as the key variable. This research is carried out to derive a direct proportionality between charging time and the capacitance.

METHODOLOGY

Moving parallel plate type rotary variable capacitor is used as the sensing element. For a variable capacitor, the area of coincided plates is proportional to angle.

$$\text{Capacitance} \propto \text{angle.}$$

Charge of a capacitor is given by $Q = CV$. Where Q is charge, C is capacitance and V is voltage. Differentiating both sides with respect to ‘t’ gives equation (1)

$$\frac{dQ}{dt} = C \frac{dV}{dt} \Rightarrow i = C \frac{dV}{dt} \dots \dots \dots (1)$$

Where ‘i’ is the current through the circuit. Integrating both sides with respect to t and making ‘i’ constant gives the equation (2)

$$it = VC \dots \dots \dots (2)$$

If variable taken as capacitance, time taken to charge the capacitor to a fixed voltage is proportional to capacitance. This yields to:

$$t \propto C$$

The capacitor charging circuit can be implemented as shown in Figure 4. The constant current supply is achieved by maintaining the voltage at node A constant.

Applying Kirchhoff’s current law to node A gives equation (3)

$$i_R + i_C = 0 \Rightarrow \frac{(V_{in}-V_A)}{R} + C \frac{d(V_C-V_A)}{dt} = 0 \dots \dots \dots (3)$$

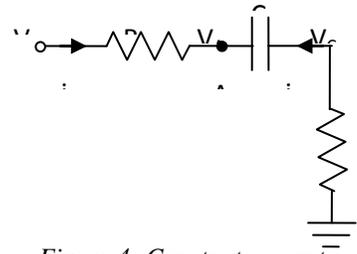


Figure 4: Constant current charging

Integrating both sides with respect to 't' gives equation (4)

$$\frac{(V_{in} - V_A)}{R}t + C(V_C - V_A) = constant \dots \dots \dots (4)$$

The capacitor is the independent variable and the voltage ($V_C - V_A$) is predefined. Constant is due to the initial charge of the capacitor. This can be ignored if the initial charge is set to zero. Expected relationship can be achieved as given in equation (5).

$$t = \frac{-(V_C - V_A)R}{(V_{in} - V_A)} C \dots \dots \dots (5)$$

To maintain V_A at a constant value, an operational amplifier configured as an integrator. Figure 2 shows the circuit arrangement. The output voltage is equal to the integration of the input voltage. Considering the op-amp has zero offset at differential inputs and applying Kirchhoff's current law to node A gives,

$$\frac{V_{in}}{R} + C \frac{d(V_{out})}{dt} = 0 \dots \dots \dots (6)$$

Integrating both sides with respect to 't' gives,

$$V_{out} = \frac{-1}{RC} \int V_{in} dt \dots \dots \dots (7)$$

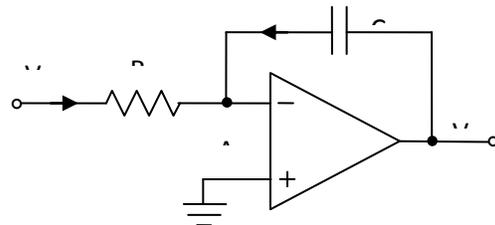


Figure 5: Op-Amp Integrator

Since V_i is constant the relationship is achieved as, $C = \frac{-V_{in} 1}{V_{out} R} t \dots \dots \dots (8)$

The equation (8) verifies conversion of angular position into a time equivalent, prior to start integration.

Prior to starting integration, initial charge of capacitor should be set to zero. Time counter must be started (T_1) to measure the time by applying a fixed known voltage to the input (V_{in}) of the integrator. Time counter value obtained after the output voltage is increased to the predefined voltage (V_R). Final timer value is proportional to the capacitance. This process is illustrated in

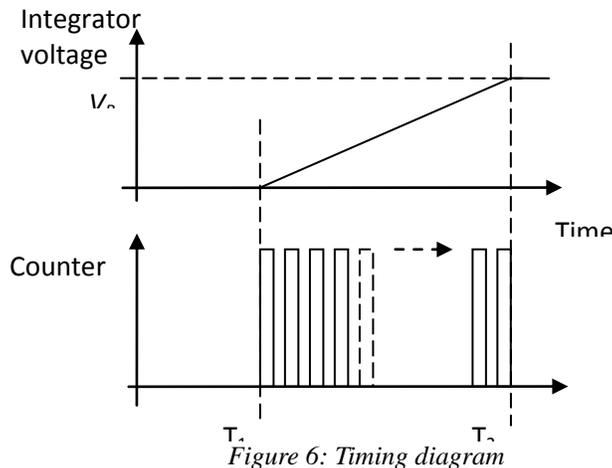


Figure 6: Timing diagram

figure 3.

- V_R = Predefined voltage
- T_1 = Instance of start of integration
- T_2 = Instance of integration stops
- $T_2 - T_1$ = Time taken to reach predefined voltage

RESULTS AND DISCUSSION

Practical aspects in capacitance measurements

To set the resolution of the measurement, the maximum measuring time and counter step duration have to be considered.

Maximum measuring time is the time taken to charge the capacitor at which the capacitance is maximum. The equation (9) used to compute the number of counter steps within the maximum measuring time.

$$\text{number of steps} = \frac{\text{maximum time (s)}}{\text{duration of step (s)}} \dots \dots \dots (9)$$

The ratio of full angular span divided by the number of steps, gives the resolution of the measurement.

$$\text{resolution}^\circ = \frac{\text{full span}^\circ}{\text{number of steps}} \dots \dots \dots (10)$$

It is clear that duration of counter step limits the number of steps per full span. According to equation (10) the resolution is inversely proportional to the number of steps.

Even though, time measurement is discrete, it is possible to get a voltage equivalent at a predefined time interval. For a short time period, the integrator can get a proportional voltage to the capacitance. This voltage can be used to integrate a 2nd integrator which has a fixed precision resistor and capacitor. A proper combination of capacitor and resistor will produce an acceptable time span for the full resolution needed. In [1] a similar method is shown with only one integrator. Therefore the resistor of integrator affects the integration time and hence the resolution. Another method shown in [2] uses a capacitive controlled oscillator which is also affects the resistor value. Double integrator method used in this research eliminates this resistor issue.

1st Integrator equation $V_1 = \frac{-V_{in}T}{R_1 C_V} \dots \dots \dots (11); 'T' \text{ is fixed time period}$

2nd Integrator equation by substituting V_1 as input $V_{out} = \frac{-(-V_{in})T}{R_1 R_2 C_V C_2} t \dots \dots \dots (12)$

Rearranging the equation with $V_{in} = V_{out}$ $t = \frac{R_1 R_2 C_2}{T} C_V \dots \dots \dots (13)$

' C_V ' is the independent variable and ' t ' is the dependent variable. Hence, the concept is proved theoretically.

According to equation (13) if the sensor is having small capacitance values, the time range will also have smaller quantities. If a fixed capacitor is added in parallel to the variable capacitor the variable range will be shifted up without changing the span of capacitance. Total integration time now has an additional time quantity added by the fixed capacitor. The new configuration is given by equation (14). This is derived from equation (13).

$$C_V + C = \frac{T}{R_1 R_1 C_1} t \dots \dots \dots (14)$$

Writing equations for the minimum and maximum capacitances and subtracting 1st equation from 2nd one gives,

$$(C_{Vmax} + C) - (C_{Vmin} + C) = \frac{T}{R_1 R_1 C_1} t_{max} - \frac{T}{R_1 R_1 C_1} t_{min}$$

$$C_{Vmax} - C_{Vmin} = \frac{T}{R_1 R_1 C_1} (t_{max} - t_{min}) \dots \dots \dots (15)$$

Referring to equation (15), it can be stated that only the difference of two time limits is required for the measurement. Therefore, minimum time is the starting time of actual time count. As a result, final output can be calculated by subtracting minimum time from counted value.

CONCLUSIONS/RECOMMENDATIONS

Mathematical model of capacitance and time relationship is proved theoretically. It can be used to measure capacitance. It is applicable for capacitive angular position transducers.

The concept is recommended for electronic angle meters.

The variable capacitor must be made application specific. Maximum span and capacitance range are the parameters to be considered. Linearity of capacitance variation over rotation is essential.

As a second phase of this research the proposed concept will be implemented. Electronic circuits with test results will be included in the next phase.

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IMPROVING THE EPIDEMIOLOGY USING THE BIG DATA ANALYSIS WITH STATISTICAL MODELS

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INTRODUCTION

The popularity of social media with improved performance in analytics will trigger the benefit of using large data sets to other industries as well. The advancement of the IT technologies has resulted in industries moving towards the “big data” analysis rather than the sample techniques. In day to day life, new diseases are evolving with complex issues where some require root cause analysis, therefore preventing diseases should be a very important task to be handled effectively and vigilantly so as to accommodate world changes.

According to the medical research continuity, there is a heavy cost to be borne by individuals to carry out the research, unfortunately most of the funding organization focus on their own interest. In this context some automated systematic approach should be developed to find the risk factors and its changes. Mathematics and IT have long been an important tool for understanding and controlling diseases on a large scale.

The medical arena epidemiology unit is tasked with disease preventing, monitoring and controlling. The epidemiology was first developed to discover and understand the possible causes of contagious diseases like smallpox, typhoid and polio among humans. It has been expanded to include the study of factors associated with non-transmissible diseases like cancer, and of poisoning caused by environmental agents. Epidemiologists determine risk factors associated with diseases and protect people from those diseases. Epidemiological studies can never prove causation; that is, it cannot prove that a specific risk factor actually causes the disease being studied. Epidemiological evidence can only show that this risk factor is associated with a higher incidence of disease in the population exposed to that risk factor.

METHODOLOGY

The methodology illustrates the information clustering and diseases risk factor identification to create a common model to predict individual risk. It predicts the individual risk level based on the possible significant diseases which effect health or economically. Further analyses provide the optimization of the factors to reduce individual risk levels using various BIG data clustering techniques to make the healthcare information a defined structure to analyze. The methodology explains a common way to create a model and its automated approach to predict the risk level of disease, which impacts an individual according to the current information or changing factor patterns.

Step1: Initial risk factors have been selected from past research and other accepted sources which continue analysis by system and adjust based on the historical information and ongoing data changes. It derives the new factors dynamics without performing the additional sampling or guesses. Use the various factor analysis techniques to eliminate the non-significant factor from the model creation. Non-significant factors hold on for future evaluation based on the new records included in the system.

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Step 2: Qualitative factors are reclassified further into sub levels to express mathematical models which can be automated and quantitatively measured to control in the future. Residual data sets that are impacted by disease that are not identified by the model and this data set can be further analysis to find out model variation including new factors.

$$f_j = a_0 + a_1w_1 + \dots + a_kw_k + e_j, \quad \text{where } e_j \sim \text{iid}(0,1)$$

k - no of factors which are accepted by the above hypotheses

f_j -jth factor

w_i - Sub Factor of f_j where $i=1,2 \dots K$

The weightage of the factor are calculated using probability function $a_i = P(f_i) = n(f_i)/n(D_j)$ and based on the correlation between the factors should be considered to be as separate as possible. Further cluster the factor risk level of the disease to group to minimize the variation within the cluster.

Step 3: Factor progressive of individual's values to predict using the time series mathematical model with historical information of individuals. This time series model iteratively validates to change according to the residuals. This considers changing the value of person and to determine the functions.

$$F_{jt} = c_0 + c_1f_{jt-1} + \dots + b_{jk-n}f_{jt-n} + e_j, \quad \text{where } e_j \sim \text{iidN}(0,1)$$

F_{jt} - thejth factor influence at time t

C_i - factor coefficient

e_i - Residuals (not related to the m factors)

Until residuals become to iid model adjust automatically and find out more factors from residual data set. Individual Risk Level = Max ($f_{jt}, f_{jt-1}, \dots, f_{j1}$) where t - determined by Disease Incubation time and other medical delay periods which provide the early identification.

Step 4: Create a Common Model for a Disease: This mainly considers the common way of the disease's and which patterns to determine the functions based on the factor value.

$$D_j = a_{j0} + a_{j1}f_{j1} + \dots + a_{jk}f_{jk} + e_j, \quad \text{where } e_j \sim \text{iidN}(0,1)$$

D_j - Disease impact risk level predicated for single human factors

f_{ji} = the ith factor influence to the jth Disease

a_{ji} factor jth influence weightage

k = the number of factors

e_i - Residuals (not related to the m factors)

Until residuals become to iid model adjust automatically and find out more factors from residual data set. Model has the two parts one is specific to diseases which is common for all and other one specific for an individual. Let's consider the a factor information Ω_t

Risk Level for Disease = p *Common Disease Model (Ω_t) + $(1-p)$ *Person Specific Model (Ω_t)

Ω_t - Information at t

P - probability of information accuracy of individual

a_i factor j th influence weightage for D_i

P is the probabilities of the information accuracy that are calculated by the system on the individual and system records

Factor optimization

Each disease has some set of factors, some are common for some diseases. Humans are more concerned about the major diseases which physically or financially impact them, which should optimistically reduce. System calculates the most important influence factor that gives optimum risk level reductions.

$$f_j = \sum \alpha_i * D_i$$

D_i - Disease impact risk level predicated for single human factors

f_j = the j th factor influence

a_i factor j th influence weightage for D_i

RESULT AND DISCUSSION

Death should be a common fear for every human; it's used by some of the companies as an advantage to perform as business.

When consider lung cancer to discuss concept of analysis using statistical models for explanation. The first step system that should be done is to filter data from BIG data and who is effected by lung cancer in the past which is the total cancer population in the system which undergoes various cluster and factor analysis to create the models.

The world age-standardized rate (ASR) for lung cancer is 22.9 per 100,000 populations. The estimated lung cancer population is around 1.63 million among the estimated to world population of 7.122 billion. (Source: Wikipedia)

WHO has classified lung cancer factors, let's assume that these below factors are found by the system using above mentioned analysis.

F1 -Tobacco use

F2 -Being overweight or obese

F3- Unhealthy diet with low fruit and vegetable intake

F4- Lack of physical activity

F5- Alcohol use

F6- Sexually transmitted HPV-infection

F7- Urban air pollution

F8- Indoor smoke from household use of solid fuels.

Behavioral factors (F1, F2, F3, F4, F5, and F6) can be controlled by the individual according to information and its change. However the above the factors are not detailed enough to differentiate the people and risk levels since there are differences person to person. Therefore there should be

some more information required to carry out the research. F3 – Healthy diet is not specific to analysis, it should be further sub divided to identify exact factors which impact lung cancer. Factor F2 is a quantitative value which is able to analyze common and individual progressive factors to provide the factor model

Environmental factors (F7, F8) are not controlled by individuals, however they can take some decisions according to the information available and also further sub divide to analyze how government/ communities react to those factors.

Identified factors to time series analysis will provide time variant information to model to respective factor which help to predicate in the future the factor's that changed based on the parameters in the BIG data.

This approach takes some time to accurately model and to record the necessary historic information which can be analyzed and to predict the model. However this is the initial steps for a large healthcare system which analysis should evolve with the changes.

CONCLUSION

The study is considerate of relationships between the epistemology, mathematical and “BIG Data” analysis which improves the analysis of risk factors and help to optimum elimination value. Further explains the conceptual analysis of diseases and data gathering. Since the system considers a large data set which improves the accuracy of system and its self-providing capabilities to correct residual which helps to correct the model automatically. Further analysis required to provide the final conclusion.

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ENGINEERING STUDENT'S PERCEPTION AND ATTITUDES TOWARDS NATIONAL DEVELOPMENT

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INTRODUCTION

The quality of people's life is massively dependent upon the engineering skills of those who design and develop our goods and infrastructure. (Grainger and Kestell, 2012) Engineers are recognized as a valuable asset for the economies in which they work, in particular because of their contributions to innovation and productivity. (Matthew, 2012) Every year, a large number of students throughout Sri Lanka come to earn their qualifications in engineering disciplines. To cater for these students private engineering colleges and universities of technology are mushrooming all over especially in the main cities in Sri Lanka. These engineers become future leaders and professionals who contribute to social wellbeing and national development and therefore, the quality of an engineer's education and their attitudes towards national development have immense significance. According to Goh et al., 2008, future engineers should have the ability to work in a multi-disciplinary multi-cultural way with deep technical knowledge to address global challenges. But the general aim of engineering studies is to become an engineer; it is not a requirement of students to have knowledge in multidisciplinary domains such as environmental education and studies in sustainable society and development. However, these are recommendations for professional engineers especially according to the Washington Accord. Scott and Yates, (2002) said that, while technical expertise is a necessary capability for successful practice it is certainly not sufficient. In the end students should have multidisciplinary domain knowledge and approaches accommodating success stories in engineering activities. Also it is a prerequisite for a student to acquire interdisciplinary studies to achieve success in the engineering profession. Therefore, this study was carried out to evaluate newly enrolled engineering students' perspectives on becoming professionals, to assess personal commitment of engineering students to contribute to national development and enhance well-being of society through exploitation of knowledge and to promote sustainability of natural resources.

METHODOLOGY

This study was focused on newly enrolled students group in an engineering study program that generates future engineers in different engineering disciplines. The sample was selected purposely and the group size was 110 comprising students who are employees, university students and school leavers. The questionnaire survey was conducted to evaluate student's perspectives on becoming professionals and their personal commitment to enhance social well-being, ensuring health and safety of the community. Formal and informal discussions with students were conducted to assess students' attitudes towards national development and becoming future leaders and matrix ranking was adopted to give priority to student's attitudes and commitment. Data were analyzed using a phenomenological approach and a literature survey about past studies was conducted.

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RESULTS AND DISCUSSION

General Information of Study Group

The survey was completed by 110 newly enrolled engineering students comprising employees 20%, 32.7% of university students and 47.3% of school leavers. Of the sample, 47.3% was from the Western Province, 20.0% from Central Province, 10.9% from the Eastern province, 5.5% from the Northern Province and 16.4% from the Southern Province. Figure 1 depicts the total sample of female and male enrolment in engineering courses of Civil, Mechanical, Electrical and Electronic disciplines. A total of 61.8% of the sample was male and 38.2% was female.

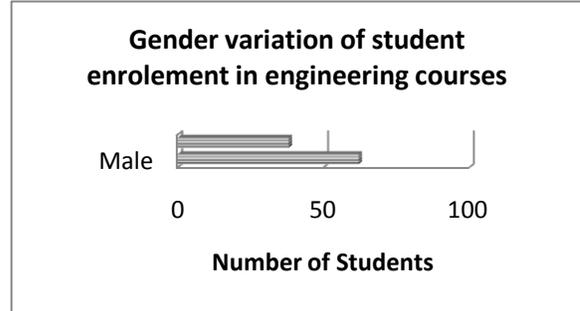


Figure 1: Male & female students enrolment

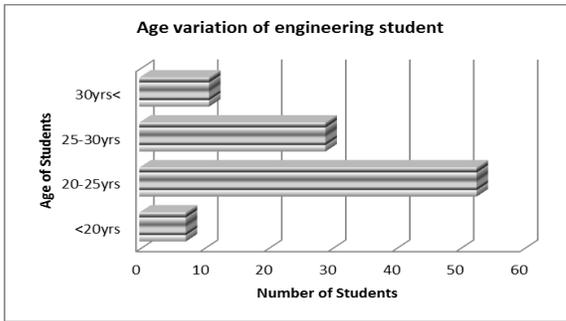


Figure 2 depicts the age variation of student’s enrolment in engineering courses. The mean age was 22.3 years and 7.3% of student were in the age range of less than twenty, 52.7% of students were in the twenty to twenty five range, 29.1% of students were in the twenty five to thirty age range and 10.9% were in the more than thirty age range . It was found that a lot of students are in the younger age group.

The results show that students who have not entered in the conventional universities, want to develop their careers in the engineering field as well those who didn’t get entry requirements for engineering studies enroll in private colleges of engineering to aquire engineering qualifications. Students in age groups of more than thirty and some students in the 25 to 30 years age group were employees and aquiring engineering qualification as it is a prerequisite for their career development. There was a wide range of economic backgrounds, with parent’s household income ranging from less than Rs. 75,000.00 to more than Rs. 75,000.00 monthly. 20.0% of students were self funded as they are employed or running their own businesses.

Meaning of engineering studies

Table 1 presented student’s perception on becoming an engineer and their future aspirations. Here student’s ideas on “why would you like to become an engineer?” were collected during the formal and informal discussions and prioritized in seven categories as presented in table 1. The first column shows student’s perspectives and other three show whether “agree”, “disagree” and ‘neutral” which meant not responded.

According to the results shown in table 1; 89.1% of students really needed to exploit their skills and capabilities to be successful in the engineering profession. 92.7% of students expected good respect and a hierarchical status in society. 49.1% of students really needed to enjoy and satisfy their career aspirations. 80.9% of students’ expectation was to have a big salary and financial security. It is an objective of the study to investigate student’s attitudinal changes after studying the engineering in context course module that has included course content like characteristics of professional engineers, engineering code of ethics and so on.

Table 1: Engineering student's perspectives to be a professional engineer

	Student's perspectives	Agree %	Disagree %	Neutral %
1	To enhance intellectual development through planning, finding and organizing and technological and scientific discovery	60.9	21.8	17.3
2	To find a career that provides enjoyment and satisfaction	49.1	19.1	31.8
3	To make a big salary & financial security	80.9	10.9	8.2
4	To exploit my knowledge & skills to contribute to the engineering field	89.1	7.3	3.6
5	Variety of career opportunities like business, design, medicine, politics, law and government	59.1	35.5	5.5
6	Profession that has good respect & high privileges at society	92.7	5.5	1.8
7	To enhance welfare, health and safety of community and contribute to national development	69.1	26.4	4.5

69.1% of students stated that they want to serve society and help the nation's development. That really shows the practice of engineering does not exist outside the domain of societal interests. (Nichols and Weldon, 2013) The critical roles of engineering is to address the pressing challenges facing our societies and to tackle issues of energy, transportation and climate change; providing more equitable access to information for our populations, clean drinking water; mandate disaster mitigation, environmental protection and natural resource management, among numerous others. (United Nations Educational, Scientific, and Cultural Organization, 2010) So this study brought some insights of newly enrolled students' aspirations to become professional engineers and future leaders to contribute to national development and enhance well-being of the community that emphasized safeguarding life, health, property, economic interests, and the public welfare or the environment. (Professional Engineering Act, 2010)

What will it take for the engineers of the futures to meet society's challenges?

According to the National Academy of Engineering, with technological innovation, the world will be intensely interconnected; those involved with technology will need to be multidisciplinary; and social, cultural, political, and economic forces will impact technological innovation. That meant the engineer who is produced in the future should have multidisciplinary skills and capabilities to address the twenty first century's engineering challenges.

Table 2: Engineering student's attitudes towards national development

	Student's Perspectives	Agree %	Disagree %	Neutral %
1	Create new system of roads, building & bridges	23.6	61.8	14.5
2	Give new innovations & creations to society	78.2	14.5	7.3
3	Give my maximum commitment to development project	60.0	20.9	19.1
4	Develop Sri Lanka & other under developed countries	34.5	50.9	14.5
5	Conserve natural environment & enhance environmental and social health	38.2	13.6	48.2
6	Designing solutions to existing problems so as to help people	50.9	20.0	29.1
7	Uplift living standards of community people	53.6	20.9	25.5

Table 2 presents several findings of student's attitudes towards national development. 78.2% of students had immense preference to develop new technologies and benefit the society. 60.0% of students were very much concerned about the present development projects and their impact on socio-economic development and the environment. 50.9% of students well understood existing problems that future engineers needed to address and to design solutions for existing problems. 53.6% of students were waiting to utilize their proficiency in engineering disciplines to ensure welfare, health and safety through uplifting living standards of community. Additionally, only 38.2% of students responded to protect the country environment and society. The amendment of multidisciplinary studies in engineering study programs can develop and train students to apply technical knowledge to reinforce sustainable social, environmental and economic development in the future. It will change future engineers' attitude towards sustainable development that is defined as development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs (Bruntland report –“Our Common Future”, 1987)

CONCLUSIONS/RECOMMENDATIONS

This study was based on preliminary data and to have well understood student attitudes change, it is a requirement to further study the same student group after four years. The newly enrolled students especially employees in engineering field have immense knowledge and understand about the importance of engineer' contribution to national development as well as protection of natural environment. School leavers are looking forward to fulfilling their engineering studies and their thoughts are not well defined for social well-being and sustainable future. It is a prerequisite of engineering students to change their attitudes to ensure elevation of standards of livings and conservation of the natural environment.

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UNCONSTRAINED GRADIENT BASED OPTIMIZATION OF QUADRATIC FORM EQUATIONS

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INTRODUCTION

Optimization influences every field such as Management, Mathematics, Accounting, Engineering and etc. Research uses either gradient or non-gradient based optimization methods for solving nonlinear forms of equation. However, research outcomes show that the gradient based methods give more accurate results than the other one. There are several optimization methods for handling constraint and unconstrained problems. For the purpose, several tools with optimization capabilities are available, namely, MS *Excel solver*, *MATLAB*, *MathCAD*, *Mathematica*, *Maple* and etc. Those tools have been developed for a wide range of requirements using a specific algorithm. Sometimes it may not be suitable to handle the problem at hand. In particular, *fminunc*- matlab function is used to handle unconstrained minimization class problems but it has several drawbacks; it can be used to execute one method at a time, need to pass method names as a parameter and it is not supported for alpha-finding method, it is difficult for analyzing or comparing output and finally it is a single function with limited features and it is difficult to understand by users.

To overcome these issues, in this research study, an attempt is made to develop a user friendly *MATLAB GUI* tool to handle a specific problem of solving unconstrained minimization problem of quadratic form equation. This tool is featured with six unconstrained gradient methods. It has two parts one for finding the solution of the given problem and other one for analyzing the methods for the particular problem. This tool will be useful for both undergraduate students and researchers who are handling the specific problems.

In this study, the principal objective is that of finding variance x for which a given function $f(x)$ is minimized. It is true that a practical design problem would be rarely be unconstrained still, a study of this class of problems is important for the following reasons:

- The constraints do not have significant influence in certain design problems.
- Some of the powerful and robust methods of solving constrained minimization problems require the use of unconstrained minimization techniques.
- The studies of unconstrained minimization techniques provide the basic understanding necessary for the study of constrained minimization methods.
- The unconstrained minimization methods can be used to solve certain complex engineering analysis problems. For example, the displacement response (linear or nonlinear) of any structure under any specified load condition can be found by

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- minimizing its potential energy. Similarly, the eigenvalues and eigenvectors of any discrete system can be found by minimizing the Rayleigh quotient.

METHODOLOGY

Classification of Unconstrained Minimization Methods

Several methods are available for solving an unconstrained minimization problem. These methods can be classified into two broad categories as direct search methods and descent methods. The direct search methods require only the objective function values but not the partial derivatives of the function in finding the minimum and hence are often called the non-gradient methods. The direct search methods are also known as *zeroth-order* methods since they use *zeroth-order* derivatives of the function. These methods are most suitable for simple problems involving a relatively small number of variables.

These methods are, in general, less efficient than the descent methods. The descent techniques require, in addition to the function values, the first and in some cases the second derivatives of the objective function. Since more information about the function being minimized is used (through the use of derivatives), descent methods are generally more efficient than direct search techniques. The descent methods are known as gradient methods. Among the gradient methods, those requiring only first derivatives of the function are called first-order methods; those requiring both first and second derivatives of the function are termed second-order methods.

Unconstrained Minimization Methods

Descent methods

Steepest descent (Cauchy) method, Fletcher–Reeves method, Newton’s method, Marquardt method, Quasi-Newton methods, Davidon Fletcher Powell method, Broyden Fletcher Goldfarb Shanno method

General Approach

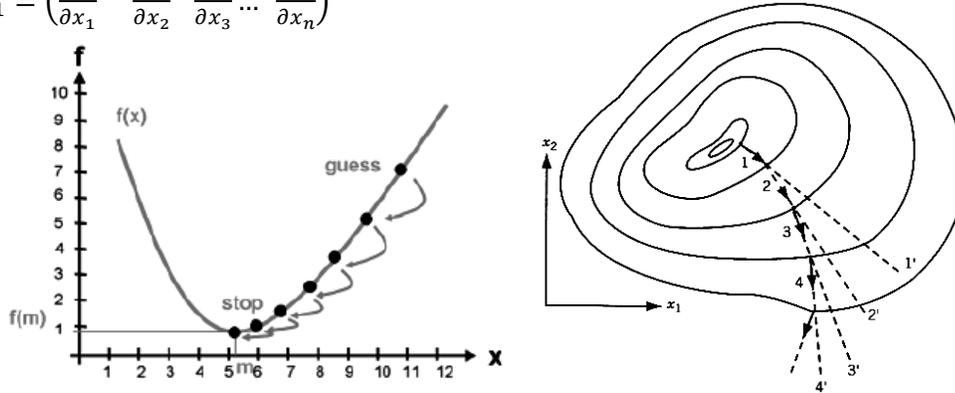
All the unconstrained minimization methods are iterative in nature and hence they start from an initial trial solution and proceed toward the minimum point in a sequential manner. The iterative process is given by $x_{i+1} = x_i + \lambda_i * s_i$, where x_i is the starting point, s_i is the search direction, λ_i is the optimal step length and x_{i+1} is the final point in iteration i . It is important to note that all the unconstrained minimization methods require an initial point x_1 to start the iterative procedure, and differ from one another only in the method of generating the new point x_{i+1} (from x_i) and in testing the point x_{i+1} for optimality.

INDIRECT SEARCH (DESCENT) METHODS

GRADIENT OF A FUNCTION

The gradient of a function is an n-component vector given by

$$\Delta f_{n \times 1} = \left(\frac{\partial f}{\partial x_1} \quad \frac{\partial f}{\partial x_2} \quad \frac{\partial f}{\partial x_3} \dots \frac{\partial f}{\partial x_n} \right)$$



The gradient has a very important property. If we move along the gradient direction from any point in n-dimensional space, the function value increases at the fastest rate. Hence the gradient direction is called the direction of steepest ascent. Unfortunately, the direction of steepest ascent is a local property and not a global one. This is illustrated in Figure below, where the gradient vectors ∇f evaluated at points 1, 2, 3, and 4 lie along the directions 11', 22', 33', and 44', respectively. Thus the function value increases at the fastest rate in the direction 11' at point 1, but not at point 2. Similarly, the function value increases at the fastest rate in direction 22' (33') at point 2 (3), but not at point 3(4). In other words, the direction of steepest ascent generally varies from point to point, and if we make infinitely small moves along the direction of steepest ascent, the path will be a curved line like the curve 1-2-3-4 in Figure given below

Since the gradient vector represents the direction of steepest ascent, the negative of the gradient vector denotes the direction of steepest descent. Thus any method that makes use of the gradient vector can be expected to give the minimum point faster than one that does not make use of the gradient vector. All the descent methods make use of the gradient vector, either directly or indirectly, in finding the search directions. Before considering the descent methods of minimization, we prove that the gradient vector represents the direction of steepest ascent.

Evaluation of the Gradient

The evaluation of the gradient requires the computation of the partial derivatives $\frac{\partial f}{\partial x_i}, i = 1, 2, \dots, n$.

There are three situations where the evaluation of the gradient poses certain problems (i) The function is differentiable at all the points, but the calculation of the components of the gradient, $\frac{\partial f}{\partial x_i}$, is either impractical or impossible (ii) The expressions for the partial derivatives $\frac{\partial f}{\partial x_i}$, can be derived, but they require large computational time for evaluation (iii) The gradient ∇f is not defined at all the points.

In the first case, the forward finite-difference formula,

$$\frac{\partial f}{\partial x_i} |_{x_m} \approx \frac{f(x_m + \nabla x_i u_i) - f(x_m)}{\nabla x_i}, i = 1, 2, \dots, n$$

can be used to approximate the partial derivative $\frac{\partial f}{\partial x_i}$ at x_m . If the function value at the base point x_m

is known, this formula requires one additional function evaluation to find $\frac{\partial f}{\partial x_i} |_{x_m}$. Thus it requires n

additional function evaluations to evaluate the approximate gradient $\frac{\partial f}{\partial x_i} |_{x_m}$. For better results we

can use the central finite difference formula to find the approximate partial derivative $\frac{\partial f}{\partial x_i} |_{x_m}$

$$\frac{\partial f}{\partial x_i} |_{x_m} \approx \frac{f(x_m + \nabla x_i u_i) - f(x_m - \nabla x_i u_i)}{2\nabla x_i}, i = 1, 2 \dots, n.$$

Newly developed Tool

In the main window, if ‘Unconstrained method’ is selected, it will prompt another window where,

- User can insert a function in the given textbox labeled as ‘function’. (It’ll be allowing only quadratic functions.)
- Then user can choose the *unconstrained methods*.
- User can give the initial values of the variables.
- User has to choose the step size and tolerance.
- Then user can get the output of whole selected methods with iterations results and its graphical representation.
- Last window will show all methods’ output in the same table for comparison.

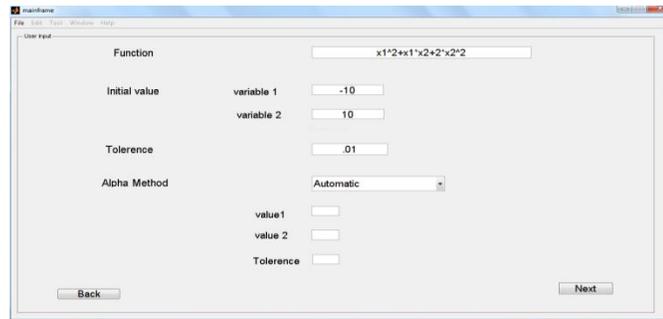


Figure 7 User Input

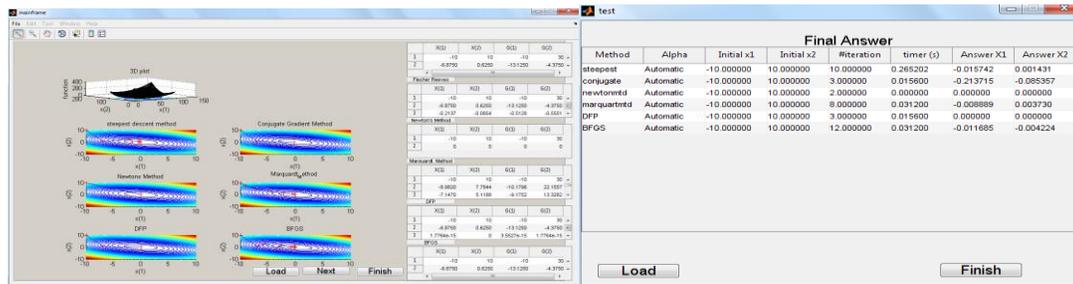


Figure 2 Comparison wind

The figure 1 shows input function $x_1^2 + x_1x_2 + x_2^2$ and tolerance 0.01 and initial values 10, -10 for x_1, x_2 respectively, with this selection of step size method as *Goldensection* and initial value for this step size method as 1, -1 and tolerance as 0.01. In figure 3 shows the analysis part for whole six methods and its graphical outputs and analysis part for each method. This is easy to compare each method with figure 2 and suggest which method gives more accurate answer of the given problem.

CONCLUSION

The newly developed MATLAB tool is successfully in solving the unconstrained optimization problem of functions of the quadratic form. The comparison of the methods has successfully been done by this tool. Any order of the function can be minimized and find the optimum using this tool because it converts the function to quadratic form and solves it based on gradient based optimization methods. In the comparison, user can analyse and identify the suitable alpha finding method for a specific problem using the output table “Final Answer”. This tool is very useful for researchers to verify their results by comparing all the gradient based methods at a time and the undergraduates to understand and compare popular optimization methods.

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ALGORITHM ASPECTS OF RUBIK'S CUBE 3D GAME

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INTRODUCTION

The Rubik's Cube is a really captivating and fascinating puzzle and it is a 3D game. There are several applications available on Rubik's cube. Some of them are games with solutions. But there is no user friendly tool which guides how to solve the Rubik's cube. To overcome this problem this paper presents a different user friendly method to solve the problem. In this application if the user is not familiar with solving cube, they can get the automatic solution which will give the steps to solve the cube. The main objective of this project is to create an algorithm which helps users to solve the cube game quickly.

In a classic Rubik's cube, each of the six faces is covered by 9 stickers, among six solid colors. A pivot mechanism enables each face to turn independently, thus mixing up the colors. The main target of the puzzle is to show that each face of the cube is in a solid color. There are 6 center color pieces of different colors. Their relative positions cannot be changed. They can only rotate around their own spindles. The color of a cube face is therefore decided by its center piece. There are 12 edge pieces, each with two colors and 8 corner pieces each with three colors in different combinations.

Learning to solve the Rubik's Cube helps to teach many life lessons such as following directions, perseverance, memorization and focus. It helps the users to imagine 3 dimensions.

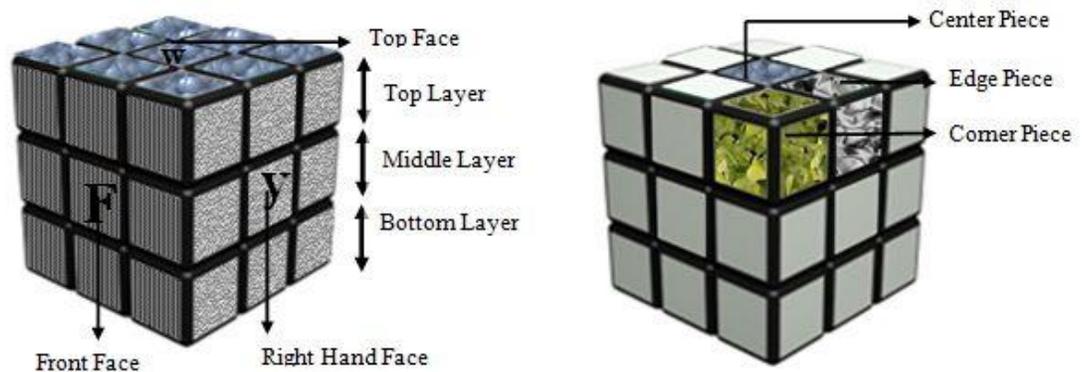


Figure 1: Rubik's Cube Structure

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The main 5 steps of the algorithm to solve the Rubik's cube are given below.

Step 1: Solve the top layer edge piece:

In the numbering system original positions are 11, 12, 13 and 14. There are two Algorithms to identify the turns to get 11, 12, 13, and 14 to original position. In the first step (means all 4 pieces are not in the correct position) first Algorithm is used where there is no need to shuffle already taken pieces. But after making one piece to the correct position the normal Algorithm is used.

Step2: Solve the top layer corner piece:

Second step is to solve the Top Layer corner Pieces. The original positions 15, 16, 17 and 18 of the numbering system are kept.

Step3: Solve the middle layer edge piece:

Third step is to solve the Center Layer edge Pieces. The original positions 22, 32, 42, 52, 24, 34, 44 and 54 of the number systems are kept. The center corner pieces have pair of numbers. These are (22, 54), (32, 24), (42, 34) and (52, 44).

Step4: Solve the bottom layer corner piece

In this step, the numbers 65,66,67,68 are to taken to the correct Position. To do that, first check the bottom side and its pattern. If 65, 66,67 and 68 are on the bottom of the cube then check the 27,28,37,38,47,48,57,58 if that is on place now the step 4 is solved. If the third layer corner pages are not in place, re-do the pattern for that and repeat the step 4.

Step5: Solve the bottom layer edge piece

First take the numbers 61, 62, 63 and 64 to the correct Position. To do that, first check the bottom side and check for the pattern. According to the pattern match, the step 5 is solved. If 61, 62, 63, and 64 are on the bottom of the cube then check the 23,33,43, and d53 is correct place, if so the step 5 is solved else check for pattern and repeat the step.

RESULTS AND DISCUSSION

The Rubik's cube is created in 3dimension. It can rotate whole cube using mouse and rotate the layers using 12 turn buttons. The user can shuffle the cube then click the start button and they can play the game using 12 turn buttons. During the playing time it counts the number of turns and time. If the user finishes the solving process successfully it gives the success message with the total time and number of turns taken. The user can show the animation guide of how to solve Rubik's cube through clicking the shuffle button then clicking the get solution button. Then if the user click next and previous button, it gives the solution step by step and details of turn in each step. This application is very useful to studying about solving the Rubik's cube. If the user clicks automate solution, the cube is solved automatically by using the algorithm.

Some important features of this Application

- 3D Cube with the mouse rotation.
- Turn each side of Rubik's cube with animation.
- Play the Rubik's cube by counting no of turns and time.
- Get step by step solution using Rubik's cube algorithm.
- Get the solution guides in help document.

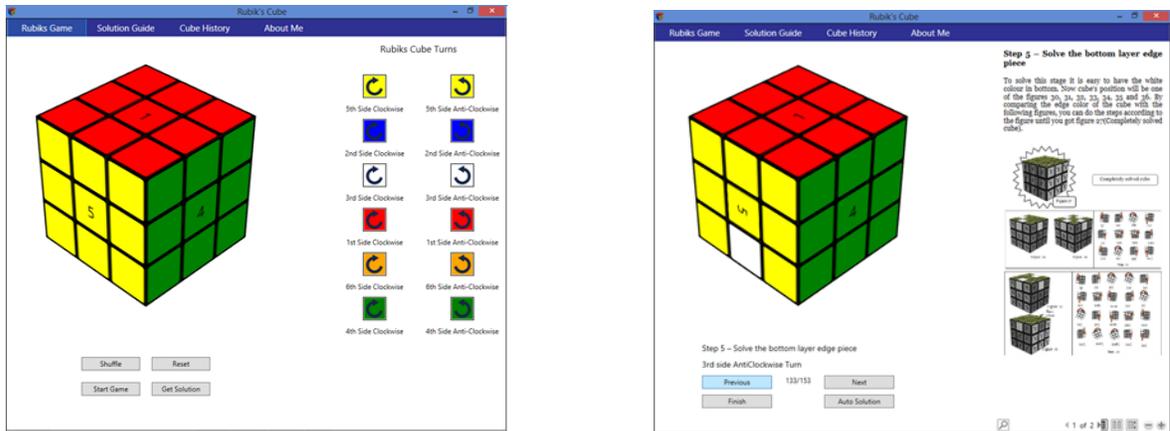


Figure 4: Application User Interface

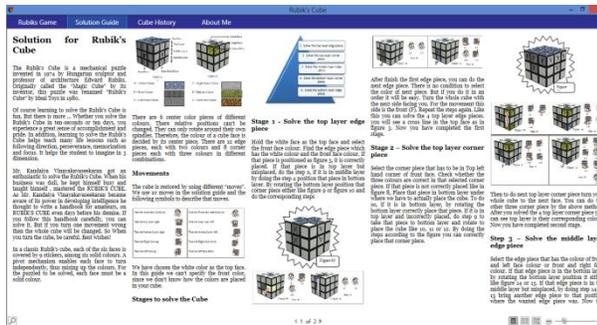


Figure 5: Solution Guide for Rubik's Cube

CONCLUSIONS

Rubik's Cube Algorithm is successfully developed to solve the Rubik's Cube and play the game. Learning Rubik's Cube is a good exercise which will teach many life lessons such as following direction, perseverance, memorization and focus. This application is developed in a more user friendly manner and it helps users to learn Rubik's cube as it gives the solution step by step. Using this tool, any user who has no knowledge on Rubik's can understand a complete picture of it. If users get trained in using this application, they can finish the game with minimum number of turns. And also they can become either an expert in playing the game or can easily win in Rubik's competition.

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CLASSIFICATION OF MESHING ALGORITHMS AND ELECTROMAGNETIC SIMULATION MESH GENERATORS

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INTRODUCTION

Electronic design engineers now use sophisticated simulation software to accurately analyze and optimize designs prior to constructing a physical prototype. The rapid growth in the communication and high-speed electronics industries is demanding more electromagnetic simulation software. In particular, the high-performance computer industry provides a good test case of the present and future demand for advanced electromagnetic simulation (EMS) software. In particular, this paper focuses on the 2D electromagnetic field problems which are governed by Partial differential equations. It is well known that the accuracy of the solutions to the problem is mainly based on using an appropriate finite element mesh generator.

Since there are many mesh generators available to handle the electromagnetic field problems several analysis engineers and researchers still face problems in identifying suitable mesh generator for a certain class of the problems. Thus, this paper addresses this issue and overcomes the problem through a survey.

A new generation of finite element mesh generators is introduced every nine months or so, with growing speeds doubling every 18 months. Numbers of electromagnetic mesh generators have already reached about 50. Mesh generators will quite probably be available within the next few years. At those rates, even short transmission lines will act as antennas, producing unwelcome amounts of electromagnetic (EM) interference and cross-talk. If high-speed computer systems are to be designed that minimize this interference, success will certainly require rigorous EM analysis, in which simulation software plays a vital role.

This paper presents current trends and available finite element mesh generators for electromagnetic field problems. It will be very useful for researchers to identify the most popular mesh generator software to easily carry out their research in the area of electromagnetic field. It is further provided comparing some of the main features of currently available mesh generators.

Software vendors have already foreseen this need for good electromagnetic simulation tools. High-frequency simulators have been on the market since 1989 and low-frequency programs for even longer. Borne forward by rapid advances in computer hardware and new EM algorithms, software vendors have introduced over 20 diverse electromagnetic software packages in the past five years. The programs simulate applications that span the electromagnetic spectrum from the low-frequency band to microwave frequencies to optical problems.

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Before the rise of these programs, EM field calculations were the business of only a small population of electrical engineers who had special knowledge of numerical algorithms and the ability and patience to write page upon page of FORTRAN code. Today any engineer who can push a mouse around can start performing an electromagnetic analysis in a matter of hours. Good results from simulation software can be obtained with no expertise in numerical EM, but a basic understanding of numerical methods and their relative merits and faults is quite helpful for selecting and, of course, getting the most out of a simulator. Several good books on computational electromagnetic have been published. The shopper's challenge is in choosing a package that fits the application, computer resources (speed and type), and budget.

Besides the primary triad of features-application, platform, and budget-several more specific features can help narrow down the choices: how the package's major modules (input modeling, analysis, and output) interact; the ease of constructing the input model or the level of detail that can be represented; the specific algorithms used and the user's freedom to manipulate them; and the flexibility and capability of the output presentation-the most accurate data in the world are ineffective if you can't make any sense out of it.

It is impossible to classify all electromagnetic devices and problems that an engineer may wish to solve. Still, three broad classes of applications can be identified for which Mesh Generators for EM field problems are readily available. One class consists of low-frequency devices such as electric motors, transformers, and actuators. Broadband electronic circuits, such as computers, are another class of devices for available. Devices in the last category are those that require high-frequency electromagnetic analysis and include antennas, radar systems, and microwave components. In this case, electromagnetic simulators serve to predict S-parameters, radar cross sections, and radiation patterns. High-frequency devices are the toughest to analyze, because of the heavy computational demands they make. Other common problems in the Electromagnetic field are: Inverse Problems, Eigen Value Problem, Static Problem, Microwave Problem, Electromagnetic Induction, Transmission and Time varying Problems.

The iterative nature of Finite element analysis (FEA) makes the analysis of models impractical by hand but perfect for computers. Several electromagnetic FEA packages exist, ranging from fully three dimensional packages such as ANSYS and Maxwell 3D, to simpler 2-D packages like Maxwell 2D, Quickfield, and FEMM. All FEA computer simulations consist of three parts; the preprocessor, analysis, and postprocessor. The preprocessing consists of constructing the model from nodes, curves, and surfaces, defining boundary conditions and block labels, and generating the mesh. Analysis is the automated process where the model is solved using the prescribed conditions and computational procedures. Post processing involves the visualization, study, and analysis of results. In electromagnetic models, this often involves a flux density plot, and the determination of circuit characteristics.

METHODOLOGY

The journal articles, research papers relevant to the process of mesh generation are referenced in this survey. Currently over 30 journal articles are referenced from the International Meshing Roundtable, Symposium on Trends in Unstructured Mesh Generation, International Conference on Numerical Grid Generation in Computational Field for past twelve years. Information about the software could be obtained from software vendors, research labs and educational institutions via e-mail. The journal articles, research papers referenced in this survey all are relevant to the process of mesh generation. All materials needed for this project are readily available on the internet. Probably the simplest approach is to first break down the technology based on the shape of element generated. Triangle and quad generation methods in 2D and tetrahedral and hexahedral methods in 3D are considered. After a suitable mesh generator will be chosen

according to type of the problem, element type of the mesh, algorithm used in mesh generator, post processing features and for a tight budget.

RESULTS AND DISCUSSIONS

Developers of EM simulation programs must perform a balancing act: develop an EM package general enough for different applications yet with enough special features to adapt it to one particular application. Users of programs that try to be "all things to all people" often have found that they lack the specific tools necessary to solve their particular problem. To circumvent this predicament, some vendors have turned to a modular style in developing their product line. Modularity lends itself well to the solution of EM problems, since the process itself can be broken down into several steps: the geometrical modeling of the physical object; the creation of an analytical mesh; the analysis proper; and finally the post processing.

Recent theoretical advances in computational electromagnetic have resulted in a host of new algorithms for EM analysis, many of which have entered commercial software. The programs investigated for this research utilized nine different numerical algorithms (see Table 1). These include finite-element method. This method offers advantages and disadvantages that fit it more to a certain class of problems than to the others.

Table 1: Meshing Algorithms and Electromagnetic Simulation Mesh Generators

Mesh Generators	Algorithms	Pckages
Tri/Tetrahedral Meshing	Octree	Nil
	Delaunay	EMAG, CADfix, EasyMesh, FELISA, GMSH, NETGEN
	Advancing Front	EMAG, CUBIT, EasyMesh, FELISA, GridTool, NETGEN, Preproc
Quad/ Hexahedral Meshing	Mapped Meshing	EMAG, CADfix, CUBIT, GMSH, TrueGrid
	Quad Meshing	EMAG, GMSH
	Hex Meshing	EMAG, CADfix
	Hex-Dominant	EMAG, CADfix

Surface Meshing	Parametric Space	EMAG, CADfix, FELISA, GMSH, GridTool, NETGEN
	Parametric mesh	Common algorithms [5,6]
	Direct-3D	CUBIT

Devices in the last category are those that require high-frequency electromagnetic analysis and include antennas, radar systems, and microwave components. In this case, electromagnetic

Table 2: Comparison of Electromagnetic Mesh Generators based on Some Constraints

(**Rating:** for *Used Algorithms*: (10- Very Efficiency Algorithm), for *Pricing*: (10- Very low price), for *others* (10- Very good))

Mesh Generators	Used Algorithm	Constructing Model	Presenting Results	Number of Users	Customer Support	Pricing	Platform Support	Input Support	Average Rating
EMAG	10	10	10	8	10	5	8	10	8.875
BAMG	8	8	8	2	5	10	6	6	6.625
CADfix	9	7	8	6	10	7	8	10	8.125
CUBIT	7	6	6	7	10	8	4	8	7.000
EasyMesh	7	6	6	8	5	10	2	6	6.250
FELISA	7	6	7	4	10	10	4	6	6.750
GMSH	8	8	7	3	10	8	8	7	7.375
GridTool	6	6	7	5	10	9	4	5	6.500
MAFIA-M	6	6	6	7	10	8	8	8	7.375
Mentat	6	6	7	9	10	7	8	8	7.625
NETGEN	7	8	8	6	10	10	8	5	7.750
TrueGrid	5	6	5	7	10	8	8	5	6.750

Simulators serve to predict S-parameters, radar cross sections, and radiation patterns. High-frequency devices are the toughest to analyze, because of the heavy computational demands they make.

CONCLUSION

This paper presents the updated database of the modern EM simulators suitable for modeling of Electromagnetic Field Problem. Most of the papers published in the past ten years are considered as references for this research study.

Some of the first EM simulation programs were intended for low-frequency devices, so that this category includes some truly mature products from vendors such as Ansoft, Magsoft, and Infolytica. Broadband electronic circuits, such as computers, are another class of devices for

which EM software tools are available. Planar 2-D and 3-D circuit simulators are available from vendors like Sonnet Software, Bay Technology, and Hewlett-Packard. Devices in the last category are those that require high-frequency electromagnetic analysis and include antennas, radar systems, and microwave components. Recent advances in computationally efficient high frequency algorithms have found their way into several products from Ansoft, Hewlett-Packard, Remcom, Electromagnetic Applications, Vector Fields, and other vendors. Recently, a new algorithm with special mesh generator was introduced to handle electromagnetic transient problems. This generator ensures the continuity of object function through the parameter optimization process.

The findings of this research will be very useful for researchers to identify the most popular mesh generator to easily carry out their research in the area of Electromagnetic Field.

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DEVELOPMENT OF ASPARAGUS (*asparagus officinalis*) BASED CANNED GROUND SOUP MIX

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INTRODUCTION

Asparagus officinalis is an important luxury vegetable crop more popular in Europe and is a good source of vitamins, antioxidant and fiber but is not affordable to everyone. It is a potential vegetable crop to be grown abundantly in Sri Lanka specially Puttlum and Wayamba districts but is inadequately exploited due to its highly perishable nature. As food trends and consumer demand for new products is being diversified, ready to cook products which are enriched with vitamins and that are likely to have health benefits at low cost are vital. The nutritive value of Asparagus, its palatability, easy digestibility, and low cost of production fulfill the emerging demand. In spite of its high nutritional values and high adaptability to the tropical climate Sri Lankans have not exploited this potential to develop a marketable product. Therefore, it is a timely approach to investigate such product development which caters to the emerging demand. Therefore, the objective of this experiment was to produce low cost new soup mix using asparagus to suit the palatability of the Sri Lankan population and to assess its quality.

METHODOLOGY

The study was conducted at the Industrial Technology Institute, 363, Bauddhaloka Mawatha, Colombo 7. High-quality spears with a butt diameter of 10-20 mm were selected and trimmed to 180 mm length. Prior to weighing, the asparagus were submerged in running water for 5 min and drained for 1 min. Peeled and washed asparagus were blanched for 3 to 4 min in water at 88°C. During the study different textural groups of asparagus which are ground (using muslin cloth, 600 µm test sieve, homemade grinder) and pieces (1.5 mm and 1 inch thickness) forms were used as different treatment combinations with a defined ratio of chicken stock, vegetable stock, corn and other ingredients to select the best textural group of soup mix sample resulted from individual four sub experiments stated in Table 1. Vegetable stock was prepared using cleaned peeled vegetables: carrot 100 g, onion 50 g, cabbage 100 g, leeks 100 g, tomato 50 g were blanched and cut into small pieces, were added with 850 g water and boiled for 30 min. and it was strained. Chicken stock were prepared using cleaned chopped chicken breast of 1 kg was added to 1.86 kg of water and boiled for 45 min. Then it was strained to get clear chicken stock. The corn starch was prepared by adding 50 g of water in to 6.274 g of corn powder. Best textural soups mixed samples were selected by conducting a nine hedonic scale with 15 trained panelists. To avoid layer separation, the selected best sample were subjected to 0.1 % and 0.2 % CMC (Carboxymethyl Cellulose) levels for two flavors (chicken and vegetable) and selected the best level of CMC to get the final recipe of the asparagus soup mixed sample. By conducting a sensory analysis, best soup mix sample was selected.

The best soup mix samples were subjected to heat penetration study (121⁰ C, 1.5bar) to obtain the F- value. Best samples were subjected for real trail production by using the F value obtained. Then the samples were subjected to commercial sterility determination as per the SLS 516 part 10. Then the best soup mix samples were subjected for final sensory evaluation and then nutritional analysis was carried for moisture, total fat, protein, crude fiber and ash according to the methods in AOAC, 1990. At last the least cost analysis was done to the resulted best soup

mixed samples compared with the commercial brine asparagus sample. The samples were in triplicate throughout the research. Non parametric data were analyzed using one way ANOVA, Kruskal-Wallis test was conducted at 5% significant level.

Table 01. Treatments of the experiment

Sub Experiment	Treatments
Sub Ex 1:-Asparagus Ground, 1” Chunk	T1- Chicken flavor ground asparagus T2-Chicken flavor 1”chunk asparagus T3-Vegetable flavor ground asparagus T4-Vegetable flavor 1”chunk asparagus
Sub Ex 2:-Asparagus Ground, Muslin,600µm	T9-Chicken flavor ground asparagus T10-Chicken flavor muslin strained asparagus T11-Chicken flavor 600µm test sieve asparagus T12-Vegetable flavor ground asparagus T13-Vegetable flavor muslin strained asparagus T14-Vegetable flavor 600µm test sieve asparagus
Sub Ex 3:-Asparagus Ground, 1.5mm sized pieces	T5-Chicken flavor ground asparagus T6-Chicken flavor 1.5mm sized asparagus T7-Vegetable flavor ground asparagus T8-Vegetable flavor 1.5mm sized asparagus
Sub Ex4:-CMC level 0.1%,0.2% Chicken flavor(Carboxy Methyl Cellulose)	T15-Chicken flavor ,0.1%CMC,1.5mm asparagus T16-Chicken flavor ,0.2%CMC,1.5mm asparagus T17-Chicken flavor ,0.1%CMC,ground asparagus T18-Chicken flavor ,0.2%CMC,ground asparagus
Sub Ex5:-CMC level 0.1%,0.2% Vegetable flavor	T19-Vegetable flavor,0.1%CMC,ground asparagus T20-Vegetable flavor,0.2%CMC,ground asparagus T21-Vegetable flavor ,0.1%CMC,1.5mm asparagus T22-Vegetable flavor ,0.2%CMC,1.5mm asparagus

RESULTS AND DISCUSSION

Table 2. Sensory analysis of Asparagus soup ground form Vs 1 inch chunk pieces

Sample	Colour	Appearance	Taste	Texture	Aroma	Acceptability
T1	8	7	7	7	7	7
T2	7	7	7	6	7	6
T3	7	7	7	7	6	6
T4	5	6	6	6	6	6
Probability	0.010	0.003	0.079	0.299	0.288	0.022

Qualitative data of different soup mixed were illustrated in the Table2. Colour, appearance and overall acceptability were significantly different at $P < 0.05\%$. Higher the ranks in the treatments better the results. T1 and T3 treatments scored high ranks for colour, appearance, taste, texture and overall acceptability. Thus, ground chicken and vegetable flavored samples were selected for further analysis and chunk samples were rejected.

Table 3. Sensory analysis of Asparagus soup ground with muslin strain Vs 600 μ m sieve

Sample	Colour	Appearance	Taste	Texture	Aroma	Overall Acceptability
T9	7	7	8	8	7	8
T10	7	7	7	6	6	6
T11	7	7	7	6	6	6
T12	6	7	7	7	6	7
T13	6	6	6	5	5	5
T14	6	6	6	6	6	6
Probability	0.018	0.103	0.004	0.000	0.069	0.003

Sensory analysis resulted Table 3 was conducted to select the best ground form of soup mix. According to the Table 3, colour, taste, texture and acceptability were significantly different at $P < 0.05$. T9 and T12 samples were highly scored for texture and overall acceptability. Thus, grounded chicken flavored (T9) and vegetable flavored (T12) were selected for next sensory analysis.

Table 4. Sensory analysis of Asparagus soup mix (ground Vs 1.5 mm piece)

Sample	Colour	Appearance	Taste	Texture	Aroma	Overall acceptability
T5	7	6	7	6	7	7
T6	7	6	7	6	7	7
T7	7	7	7	7	7	7
T8	7	6	6	6	6	6
Probability	0.502	0.239	0.035	0.062	0.467	0.031

Sensory analysis resulted Table 4 was conducted to select either ground or piece forms in order to increase the palatability of the consumer. Even though the results of taste and acceptability were significant at $P < 0.05$ but the appearance of the soup mixed were not significantly different at $P < 0.05$. Thus, ground form and piece 1.5 mm pieces forms were selected for the further sensory studies.

Table 5. Sensory analysis of Asparagus chicken flavor (CMC at 0.1 % Vs 0.2% levels)

Sample	Colour	Apperance	Taste	Thickness	Aroma	Overall acceptability
T15	8	7	7	7	7	7
T16	8	8	8	7	7	7
T17	8	7	7	8	6	7
T18	8	78	7	8	6	8
Probability	0.640	0.532	0.690	0.046	0.288	0.872

Table 6. Sensory analysis of Asparagus vegetable flavor (CMC at 0.1 % Vs 0.2% levels)

Sample	Colour	Apperance	Taste	Thickness	Aroma	Over all Acceptability
T19	7	7	8	7	7	7
T20	8	7	8	7	7	7
T21	7	7	7	7	7	7
T22	7	7	8	7	7	7
Probability	0.992	0.919	0.196	0.500	0.976	0.905

According to the Table 5, thickness of the soup sample was significantly different at $P < 0.05$. But the overall acceptability of the samples were not significant at $P < 0.05$. Hence low level of CMC 0.01 % was selected as the best level for thickening the soup mixed in chicken flavored samples. As per the Table 6 of vegetable soup, none of the parameter of organoleptic properties were not significant at $P < 0.05$. Thus, low level of CMC which is 0.1 % was selected as the best level of CMC.

Table 7. Heat penetration study of Asparagus soup mix samples

Parameter	T17 at 1/3 depth	T17 at 1/2 depth	T15 at 1/2 depth	T15 at 1/3 depth	T19 at 1/2 depth
T(time in min.)	55	59	47	51	59
T ⁰ C	118.95	118.8	119	119	118.95
Cumulative F value	4.89025	4.5791	4.9126	4.8574	5.0455

As illustrated in the Table 7, F value was calculated for the T15, T17, T19 and T21. Due to layer separation both Asparagus 1.5 mm piece chicken (T15), vegetable flavor (T21) soup mix were rejected. As per to the calculation, the come up time was 16 min and the processing time was 43 min. and others two samples of Asparagus ground chicken (T17) and vegetable ground flavor (T19) were subjected for real trail production.

Table 8. Commercial sterility of the soup mix sample

Sample	Aerobic plate count	pH
Chicken ground (T17)	Negative	5.5
Vegetable ground (T19)	Negative	5.5

Based on the results in the Table 8, aerobic plate count was negative and no changes in pH was observed. Therefore samples were suitable for consumption. According to the Table 8 none of the parameter was not significant at $P < 0.05$. At last, ground chicken and vegetable flavored samples were selected as best recipe for asparagus soup mix samples and results were illustrated in Table 9.

Table 9. Final sensory analysis of Asparagus soup mix

Sample	Colour	Appearance	Thickness	Taste	Aroma	Overall acceptability
T17	7	7	8	7.5	7.5	7.5
T19	7	7.5	8	7.5	7.5	7.5
Probability	0.094	0.910	0.705	0.650	0.880	0.791

Table 10 illustrated the comparison of nutrient content of prepared Asparagus soup and the commercial brine asparagus. It shows that prepared asparagus soup contains higher protein, fat contain than the asparagus in brine. It shows that adding of the soup ingredients like fresh milk, butter, vegetable and chicken has improved the amount of protein and fat content in the soup mix.

As per the Table 10 illustrated 400 ml of asparagus soup cost is Rs. 199.00 cheaper than the commercial brine product available in the market which is of price Rs. 334.00 for 270 drained weight.

Table 10. Nutritional Value of Asparagus soup

Nutrient	Quantity (Dry basis %)	Commercial product (Asparagus in Brine %)
Moisture	19.5	-
	91.81(wet)	-
Total fat	17.5	0
Protein	19.25	0.91
Ash	10.8	-
Crude fibber	2.2	3.6

Table 11. Cost analysis of Raw material

Raw material	Cost Rs per litre	Cost Rs per can (400ml)
Asparagus(327g)	343/-	132/-
Fresh milk(327ml)	36/-	14/-
Stock(327ml)	77/-	39/-
Butter(8g)	12/-	5/-
Spices	22/-	9/-
Total cost	490/-	199/-

CONCLUSIONS/RECOMMENDATIONS

This study characterized the physical properties of asparagus with other ingredients for the production of good quality soup mix. Soup mix contains 327 g of asparagus in ground form with level of 0.1 % CMC with chicken or vegetable flavor were acceptable in overall quality. It shows that through value addition the nutritional composition could be improved as well as the production cost could be minimized.

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QUALITY CHARACTERISTICS OF NUTRITIONALLY ENRICHED MUFFINS PRODUCED FROM PLANTAIN-WHEAT COMPOSITE FLOURS

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INTRODUCTION

Muffins have become one of the most desirable snacks for both youth and elderly people due to their low manufacturing cost, more convenience, long shelf-life and ability to serve as a vehicle for important nutrients. Most developing countries are importers of wheat flour and they are totally dependent on foreign countries for their bakery production. The possibility of using starchy staples for dough making depends on the physical and chemical properties of the baked product. Efforts have been made to promote the use of composite flours in which flour from locally grown crops replace a portion of wheat flour for use in bakery products, thereby decreasing the demand for imported wheat while producing nutritious bakery products. In Sri Lanka, plantains are a widely growing important food crop and are sources of income for subsistence farm families. There has been an increasing trend towards large-scale production of plantains. The plantain has a high carbohydrate content (35g/100g) and low fat (0.4 g/100g) content. They are good sources of vitamins and minerals, particularly iron (24 mg/kg), potassium (9.5 mg/kg), calcium (715mg/kg), vitamin A, ascorbic acid, thiamine, and niacin (Akingbala, *et al.*, 2007). Green banana flour is a low-cost ingredient for the food industry and is an alternative to minimizing the postharvest losses of plantain. The new economical strategy to increase utilization of plantain includes the production of plantain flour when the fruit is unripe, and to incorporate the flour into various innovative products such as slowly digestible muffins, biscuits, high-fibre bread and edible films. The clear advantage presented by green plantain flour includes a high total starch, resistant starch and dietary fibre content. Experiences gained in the use of composite flours has demonstrated that for reasons of both product technology and consumer acceptance, wheat is an essential component in many of these flours (Giarni *et al.*, 2004). The percentage of wheat flour required to achieve a certain effect in composite flours depends heavily on the quality and quantity of wheat gluten and the nature of the product involved (Smith *et al.*, 1998). Plantain flour contains no gluten and consequently cannot be used solely for making muffins. When plantain flours are used, a limit of substitution level with wheat flour was necessarily imposed on the extent to which the plantain flour could be used as a substitute for wheat flour in muffins. This investigation evaluated the nutritional, functional and sensory properties of muffins made from various proportions of wheat-plantain composite flours.

METHODOLOGY

Matured green plantains (*Musa paradisiaca cv. Green Java*) were purchased from the commercial farm of the Department of Agriculture. The wheat flour used was white milled grain imports from USA by the Prima Flour Mills.

SAMPLE PREPARATION

Plantain heads were cut into separate bunches which were subsequently de-fingered. The fingers were washed, peeled, cut into thin slices of 5 mm diameter and blanched in 1.25% NaHSO₃ solution at 80°C for 5 min to prevent the darkening of tissues due to enzymatic browning. Blanched plantain slices were drained and dried in an air re-circulation oven at 60°C for 24 hours. Dried plantain slices were milled into flour in a Food Hammer mill (BH 2310).

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The flour obtained was sifted through a 250 µm aperture sieve and packed in medium density (20 µm thickness) polythene bags. Composite flour samples containing wheat and plantain flours were formulated at 0, 10, 30 and 50% (w/w) level of wheat flour substitutions for making the muffins. A digital weighing balance (Metler-3200) and a blender (Philips, HR 1500) were used for weighing and mixing the flours respectively.

INGREDIENTS AND MEASUREMENTS USED FOR MUFFINS

Composite flour - 250g; Granulated sugar - 200g; Baking powder - 1 Tbsp; Salt - ½ tsp; Whole milk - 1 cup; Vanilla extract - 1 tsp; Egg - 1 large (or 2 medium); Butter or shortening - 1 Tbsp.

The following treatment combinations of plantain – wheat flour muffins were developed.

T₁– Muffin produced from flour of 100% wheat

T₂– Muffin produced from composite flours of 90% wheat and 10% Plantain

T₃ – Muffin produced from composite flours of 70% wheat and 30% Plantain

T₄ – Muffin produced from composite flours of 50% wheat and 50% Plantain

PREPARATION

The oven was pre-heated to 200°C. The composite flour, baking powder and salt were mixed and sieved thrice. The eggs were beaten in a separate bowl and the sugar, milk and vanilla were added to the egg. The muffin pan was thoroughly greased with butter. The melted butter was poured into the egg-vanilla-milk mixture and stirred well. This mixing process was repeated 3-4 more times, until all the ingredients were incorporated. The batter was poured into the prepared greased muffin pan and baked for 20 minutes.

PHYSICO-CHEMICAL ANALYSES OF MUFFINS

The physico-chemical properties of the developed muffins were investigated. The bulk density of the sample was determined by weighing the sample (100 g) into 200 ml graduated cylinder, tapping cylinders ten times against the palm of the hand and expressing the final volumes as g/ml. The Stevenson's Micro Texture Analyzer was used to determine the force involved in the compression of 2 cm core sample of the muffins. Nutritional analyses of the samples were carried out using official AOAC methods (2000) for moisture (14.004), fibre (7.0006) and ash (14.006). Soluble carbohydrate was calculated by difference. Major elements were quantified by the Atomic Absorption Spectro-photometer (Model-CARYO 2231-D, USA).

SENSORY EVALUATION

Sensory evaluation was performed 12 hours after baking to evaluate the shape, aroma, internal texture, taste and overall acceptability of the muffins. The samples were cut into pieces and served. Twenty trained panel members were randomly selected to perform the organoleptic evaluation. The panelists evaluated the samples using a 9 point hedonic scale with 9 - liked extremely and 1 - disliked extremely.

STATISTICAL ANALYSES

Data obtained in physico-chemical analyses were subjected to Analysis of Variance and mean separation was done with Duncan's Multiple Range Test (DMRT). Descriptive statistics was done on sensory attributes and the means were compared using the Tukey's test ($p < 0.05$).

RESULTS AND DISCUSSION

The results of the physico-chemical characteristics of the muffins made from the plantain-wheat composite flour are shown in Table: 1. The lowest value for bulk density of 0.31 g/cm³ was observed in 100% wheat flour muffins while the highest value of 0.47 g/cm³ was recorded in

50% plantain flour substituted product. The bulk density of the muffins made with 30% plantain flour was 0.42 g/cm^3 . There was no significant differences ($p < 0.05$) in relation to bulk density in all the muffins samples made with different percentages of plantain flour. Ogunjobi and Ogunwolu (2010) reported that the bulk density for cake made from 30% cassava flour was 0.49 g/cm^3 . Therefore, the bulk density of the muffins supplemented with plantain flour was within the acceptable level and may not have had adverse effect on the quality attributes of the product.

Table 1: Physico-chemical properties of Plantain – wheat composite flour muffins

Treatments	Bulk density (g/cm^3)	Volume (cm^3)	Texture (g)	Moisture (%)	Soluble solids (%)
T ₁	0.31 ± 0.001^a	121 ± 7.7^a	443.5 ± 27.7^a	12.6 ± 0.01^a	9.01 ± 0.16^a
T ₂	0.38 ± 0.003^a	112 ± 5.8^a	514.6 ± 17.7^{ab}	11.5 ± 0.01^a	8.75 ± 0.20^a
T ₃	0.42 ± 0.001^a	102 ± 4.3^{ab}	595.3 ± 15.7^b	10.9 ± 0.02^{ab}	7.56 ± 0.17^{ab}
T ₄	0.47 ± 0.004^{ab}	94 ± 5.1^b	645.6 ± 20.7^c	9.4 ± 0.03^{ab}	6.98 ± 0.24^b

The values are means of three replicates \pm standard error.

The means with the same letters are not significantly different from each other at 5% level on DMRT.

The texture, fibre and mineral contents of the plantain flour supplemented muffins increased with progressive increase in the proportion of plantain flour, with 30% having the values of 595.3 g, 2.14% and 3.56% respectively, while lowest values were recorded for the whole wheat muffins. The increased fibre and mineral contents at downstream dilutions of wheat flour suggest that at higher dilution levels the coarse plantain flour enhanced the fibre and mineral contents of the mixtures. There was no significant differences ($p < 0.05$) in relation to moisture content in all the muffins samples made with different percentages of plantain flour. The average moisture content value of the muffins made with 30% plantain flour was 10.9%. Plantain flour has a good potential for use as a functional agent in bakery products on account of its high water absorption capacity. Ogunjobi and Ogunwolu (2010) reported that the total moisture content for cakes and muffins should not exceed 14% and that 11% is the best. Therefore, the moisture contents of the muffins supplemented with plantain flour were within the acceptable level and may not have had an adverse effect on the quality characteristics.

As shown in Figure: 1, the fibre content of the muffins increased with the increase in the substitution of the plantain flour from 1.87% in the control sample to 2.30% in the muffins with the 50% plantain flour. The findings are in agreement with Eddy (2004). This is due to the higher fibre content of plantain flour compared to wheat flour and fibre content of the composite samples which was higher than those of 100% wheat flour. The plantain flour contains high amounts of resistant starch which possesses fibre like qualities and aids in digestion, reducing blood sugar and cholesterol levels. The soluble solid of the plantain flour supplemented muffins and the whole wheat flour muffins range between 6.98 and 9.01%, with the wheat flour muffins recording the highest value. Muffins made with 100% wheat flour contained 16.27, 94.58, 1.30 and 153.56 mg/100g for calcium, potassium, iron and phosphorus respectively. Meanwhile, at the level of 30% of replacement, they increased to 29.87, 124.2, 2.52 and 181.7 respectively.

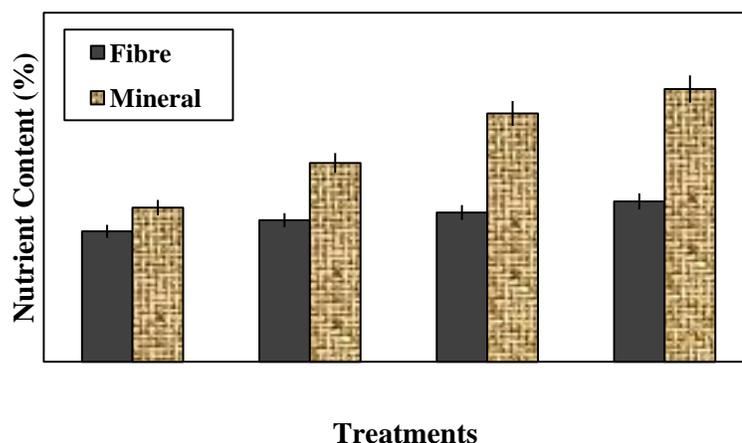


Figure: 1 Fibre and mineral content of the muffins made from Plantain-Wheat composite flours

T₁– Muffin produced from flour of 100% wheat; T₂ – Muffin produced from composite flours of 90% wheat and 10% Plantain; T₃ – Muffin produced from composite flours of 70% wheat and 30% Plantain; T₄ – Muffin produced from composite flours of 50% wheat and 50% Plantain

ORGANOLEPTIC QUALITIES

The sensory scores of the muffins prepared from the different proportion of composite plantain – wheat flour are shown in Table: 2. Tukey’s Studentized test was done to compare the means differences.

Table 2: Sensory scores of the muffins made from plantain – wheat composite flour

Treatments	Shape	Aroma	Internal Texture	Taste	Overall acceptability
T ₁	8.85 ± 0.08 ^a	8.81 ± 0.3 ^a	8.70 ± 0.18 ^a	8.77 ± 0.28 ^a	8.75 ± 0.08 ^a
T ₂	8.68 ± 0.02 ^{ab}	8.65 ± 0.2 ^a	8.59 ± 0.17 ^a	8.64 ± 0.26 ^a	8.63 ± 0.02 ^{ab}
T ₃	8.51 ± 0.20 ^b	8.47 ± 0.1 ^{ab}	8.48 ± 0.01 ^{ab}	8.50 ± 0.22 ^a	8.58 ± 0.20 ^{ab}
T ₄	8.25 ± 0.15 ^c	8.30 ± 0.2 ^{ab}	8.29 ± 0.01 ^b	8.29 ± 0.04 ^a	7.85 ± 0.15 ^b

The values are means of three replicates ± standard error. Means in the same column followed by different letters are significantly ($P \leq 0.05$) different.

The sensory evaluation showed that no significant ($p > 0.05$) differences were observed between the whole wheat flour muffins and the 30% plantain flour supplemented product in the sensory attributes of aroma, internal texture, taste and overall acceptability, but differences were significant ($p \leq 0.05$) in shape, appearance and crust texture.

Highly acceptable crust texture was obtained for whole wheat flour muffins while it was low for 50% plantain flour muffins. The importance of the protein level was due to its gluten fraction in that gluten was responsible for the elasticity of the dough by causing it to extend and trap the carbon dioxide generated during baking. When gluten coagulated under the influence of heat during baking, it served as the framework of the loaf, which became relatively rigid and did not

collapse. Plantain flour contains no gluten and consequently cannot be used solely for muffins. When used, however, a limit of substitution level with wheat flour was necessarily imposed on the extent to which the flour could be used as a substitute for wheat flour for cakes and muffins. Similar findings were reported by Nwaojigwa *et al* (2007) that the cake made from plantain-wheat flour was acceptable up to 30% supplementation level based on the sensory attributes.

CONCLUSIONS

This research was carried out to reduce wastage and improve the utilization of plantains. Wheat flour could be substituted with plantain flour in the manufacturing of nutritious muffins. Therefore, muffins with comparable nutritional level could be produced with plantain – wheat composite flour up to the substitution level of 30% plantain flour. The sensory qualities showed that the muffins supplemented with 30% plantain flour are well acceptable in terms of aroma, internal texture, taste and overall acceptability. Hence, the 30% plantain flour substituted muffins had comparable nutritional and sensory qualities to the whole wheat flour muffins. The plantain flour exists as a resistant starch which greatly lowers its glycemic index rating and contributes to digestive health and is helpful for diabetics or any others needing to choose low sugar foods. The broader economic benefits accruing from the processing of plantain fruit into flour and its use in bakery products include employment opportunity, savings in foreign exchange and stimulus to home agriculture.

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AN EXAMINATION OF FACTORS AFFECTING ON SELF INGESTION OF POISON

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INTRODUCTION

Self ingestion of poison is overdosing with a medicine or swallowing a poisonous substance (Dorland, 2012). Self ingestion of poison (SIP) is a very common way of committing suicide worldwide. It is the most common way to cause self harm and Sri Lanka is among the countries which have the highest rates of self poisoning, in the world (Ganeshwaran, Subramaniam, & Mahediwan, 1984). In 1991, Sri Lanka had the distinction of being the country with the highest suicide rate (47/100,000 population) in the world. The highest rate of self ingestion of poison as a means of self harm or attempted suicide has been seen in Thanamalwila, in the Monaragala district, in Uva province (Ministry of Health, 1997).

Jeyrathnam (1990) stated that the worldwide incidences of poisoning are as high as three million cases per year with 220000 deaths each year. Internationally, self poisoning with agricultural pesticides is the commonest cause of hospital death especially in rural districts. This number is higher than the number of admissions of all cardiac diseases and all tropical diseases (Ministry of Health, 1997). Even in the United Kingdom, deliberate self poisoning is one of the commonest reasons for hospital admissions and it represents a considerable economic burden. Gratz (2003) stated that self ingestion of poison is the most common form of non suicidal self injury behavior. Self ingestion of poison occurs in individuals of all age, regardless of gender, ethnicity or socio-economic status.

This self ingestion of poison is a huge health and social problem in Sri Lanka especially, in the Uva province which leads to increased health care cost. This wastage of health care expenditure can be reduced by preventing self ingestion of poison. Health care providers should take every possible measure to prevent unnecessary deaths and reduce the burden on health resources. In this context, an investigation of the factors affecting self ingestion of poison could be useful. Therefore, this study focuses on “examining the factors affecting attempted suicide by self ingestion of poison” using survivors of self poisoning admitted to three hospitals in Uva province namely General Hospital (GH), Monaragala, District Hospital (DH), Bandarawela and District Hospital (DH), Thanamalwila.

METHODOLOGY

This study employed a quantitative approach and descriptive design. This study was conducted in the natural settings of three hospitals at Monaragala, Bandarawela and Thanamalwila. The sample was purposive and consisted of 150 survivors of deliberate self poisoning, who were admitted to the above three hospitals during 1st of September in 2012 to 31st of January 2013. They were invited for voluntary participation and later informed consent was obtained. The patients transferred to other hospitals or intensive care units being blind, dumb and deaf, and patients who were illiterate were excluded from the sample.

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Since there are no ethical reviews boards at Monaragala, Bandarawela and Thanamalwila hospitals, ethical approval was obtained from the Ethical Review Board at Lady Ridgway Hospital (LRH) and permission to gain access to the settings was obtained from the authorities of Monaragala, Bandarawela and Thanamalwila hospitals.

The tool was developed by the research team and the final version of the English questionnaire was translated to Sinhala and Tamil languages. These translated versions were back translated to confirm the accuracy. The questionnaire consisted of 25 questions with multiple answers and aimed at gaining demographic data, motivation towards self poisoning, prior experiences of the sample to identify the childhood history, and recent past incidents for self poisoning. Questionnaires were distributed personally by the research team and were available for clarifications. The response rate was 100%.

RESULTS AND DISCUSSION

Demographic data: The sample consisted of 44% of males and 56% of females. A similar situation was identified in the study conducted by Eddleston et al. (1998). In contrast, Ariyanada (2009) revealed that more males have died in the Southern Province of Sri Lanka in comparison with females. Majority (52.6%) were married and they were the bread winners of the family.

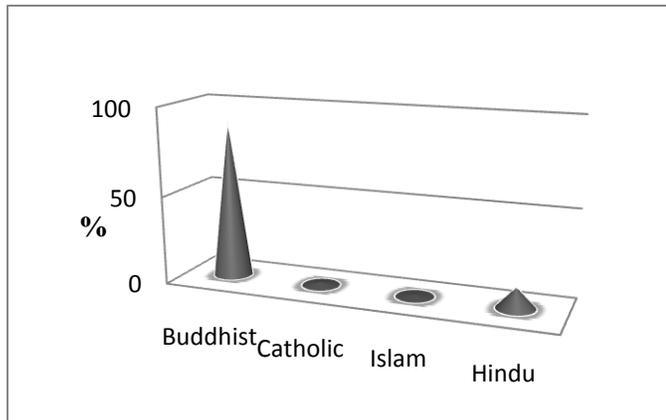
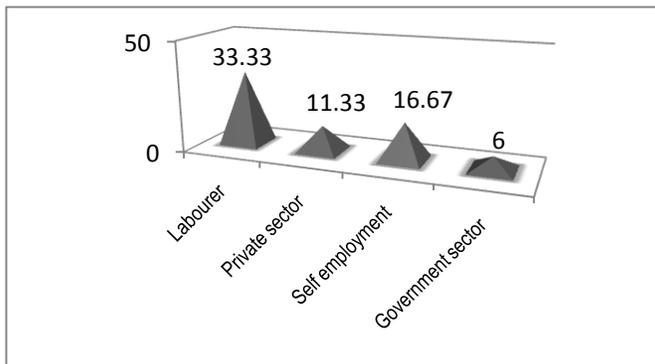


Figure 8 Distribution according to Religion

Age group is an affecting factor on committing suicide. According to the data analysis, their age ranged from 10 to 51 years and 35.6% are teenagers and 37.6% are in their second decade. A total of 73.2 were below the age of 30. According to these results younger people had attempted SIP than others. Eddleston et al. (1998) also found that many patients were very young (mean age 24.8 years).

The analysis of data according to religion showed that the majority of them (89.3%) were Sinhala Buddhist and 12% were Tamil Hindus, 2% were Catholic and 1.3% was Muslim Islam (Fig. 1). According to Islam religious law, self harm or Self ingestion of Poison is prohibited, so this religious law may be a cause for the low number of Muslims in this group. Religion seems to partially contribute to control of self ingestion of Poison.



Education level is another major factor that affects SIP. Life skills are based on educational level. The educational level was very low and 38.7% had primary education and another 46% had studied up to GCE ordinary level. They seem to be lacking in the necessary capability to make correct decisions during stressful situations.

Economic factors may be playing a

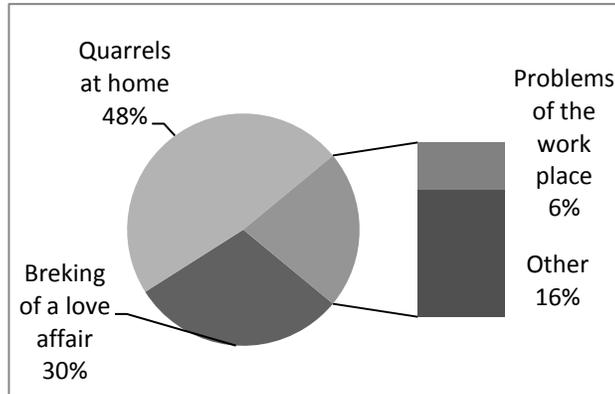


Figure 10 Reasons for Self Poisoning

considerable part on SIP. Majority of the sample were laborers or unemployed (figure -2). The monthly income of 32.6% was less than 5000 rupees and another 42.6% have an income between 6000- 10,000 rupees. It is a total of 75.2% of the sample. This income might not be sufficient in fulfilling their daily requirements thus leading to economic problems. In their study, Hettiararchchi and Kodituwakku (1992) also identified that financial problems were a common cause for attempting suicide by males than females. In addition, Monaragala, Bandarawela, and Thanamalwila are

farming areas, people are used to storing poisonous liquids in their living places without following proper safety measures. Hence poisonous substances are easily accessible by anyone.

Reasons for motivation for Self Poisoning : The data revealed that the majority of the sample had taken poison as a reaction to grief. Of the sample of 150, 131 attempted suicide by SIP without any prior planning. They had access to poison within easy reach immediately after they had faced a stressful situation. Therefore, the availability of poison within easy access seems to be another leading factor affecting SIP in the Uva province. Similar findings have been identified by Hettiarachchi and Kodithuwakku (1992).

Thanamalwila and Monaragala areas are tropical areas that grow cannabis. Most of males are addicted to cannabis as it is easily available. In addition, most of them are smokers and alcohol dependents. These males are not capable of making correct decisions. According to participants, family arguments and quarrels are very common due to alcoholism. Data revealed that drug and alcohol abuse is major factor affecting SIP in Uva Province. Children of those families have bad experiences due to unpleasant family environment. Some of the subjects of the study sample were under the influence of alcohol at the time of attempting suicide. Moreover, it was identified that single parent families are more common in those areas which leads to an unpleasant family environment for children. So, parenting problems seem to be a common feature of this sample. Experiences during childhood may be a relative factor affecting self ingestion of poison.

Table-1: Experiences during Childhood

Experience	Percentage
Sexual abuse	2%
Neglected by parents	14.6%
Unpleasant family environment	48.6%
Single parent family	8%
Family alcohol abused	46%

Regarding childhood experiences, every subject had experiences of abuse as a child in various ways (table 1). Majority (48.6%) had an unpleasant family environment, another 46% had alcohol addicted families, parents neglected 14.6% of them, and 8% had a single parent. Out of the sample, 2% revealed sexual abuse. Silva and Senevirathna (2003) stated that conflicts between spouses affect self ingestion of poison. These findings of the present study also revealed that domestic violence is a significant factor affecting SIP. There were no diagnosed mentally ill patients included in the sample but research findings revealed that they have some mental stress

These tensions may be forcing them to take poison for self harm. Abesinghe (2009) discovered depression, alcohol dependence and stresses arising within families as the three leading causes of attempting suicide.

CONCLUSION AND RECOMMENDATIONS

The main aim of the study was to examine the factors affecting attempted suicide by self ingestion of poison. The sample was survivors who had ingested poisons and admitted to three hospitals at Monaragala, Bandarawela and Thanamalwila in Uva province. Data revealed that low literacy and low educational level, low economic status were some of the major reasons for attempting suicide. In addition, lack of skills in managing anger/ stress due to younger age, inability to cope with situations such as breakage of romantic relationships were also identified as other important factors. Moreover, data revealed that mal-adaptive behavioral problems such as use of alcohol, domestic violence, as well as availability of poison within easy reach were other reasons.

Although many other studies (Silva & Senaviratna, 2003; Eddleston et al.1995) identified undiagnosed psychiatric illnesses of the sample, the evidence of this study did not support that. Probably this could be due to lack of screening for mental illnesses such as depression, delusional disorders, and alcohol dependence in the community. However, most of the sample had features suggestive of depression at the time of poisoning. As measures to reduce attempted suicide by SIP, this study would like to recommend the following.

Counseling programs for adolescents are necessary to improve life skills; handling stressful situation and decision making. The general public should be educated on taking precaution in storing poisons under lock and key, to improve parenting skills among parents, to reduce childhood hardship such as unpleasant family environment, negligence by parents and harmful use of alcohol within the family. Risk groups should be screened for psychiatric illnesses such as depression and alcohol dependent delusional disorders that lead to domestic violence.

Further studies are needed in other areas in the farming industry. As this is a social problem, it will be more useful if these studies focus on the issue from different perspectives in addition to the perspective of the person who attempts suicide by ingesting poison. By doing so, the study will become an awareness raising program.

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A PRELIMINARY STUDY ON CAUSES AND RISK FACTORS RELATED TO ACCIDENTS AMONG A SELECTED GROUP OF CHILDREN

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INTRODUCTION

Among the injuries that occur in childhood, accidents are the most common among children all over the world. Accidents are identified as the leading cause of death and injuries among children in the United States (Currie & Hotz, 2003). Accidents are the leading cause of death and also cause injuries that result in thousands of hospital admissions for children and young people each year and may lead to lifelong pain, suffering and disability among survivors in England (Ellis & Fauth, 2010). As a low and middle income country, Sri Lanka also has to face this issue of childhood accidents. It is a major public health problem that requires urgent attention. Besides, accidents are the most common cause of deaths in children over one year of age. Therefore, prevention remains a high priority (Kemp & Sibert, 1997). Furthermore, accidents among children are not necessarily purely “accidental” or random events; to a degree they are predictable and therefore largely preventable (WHO, 2005). Risk factors related to child accidents are varied and most of the accidents can be prevented by identifying their risk factors. Therefore disclosing the risk factors related to child accidents are important in making interventions to prevent them. Accordingly, the purpose of this study was to examine risk factors related to children’s accidents in the Lady Ridgeway Hospital for children (LRH). The specific objectives were to identify the guardians’ knowledge and attitudes regarding child accidents, the existing causes for accidents among children, and the barriers affecting controlling accidents among children.

METHODOLOGY

The study was conducted in the accident service of Lady Ridgeway Hospital for children during the period 30th January to 8th February 2013. Quantitative approach and descriptive design was used in this study and a self-administered close ended questionnaire was applied as the tool for the study. Parents or legal guardians of the affected children, who were willing to participate voluntarily with their competence to give informed consent were selected for the study. Ethical approval was obtained by the ethical review board of the LRH. The sampling method was random and the guardians of 150 children who were admitted during the stated period to the accident ward of LRH, with various accidental injuries participated in the study. Data was analyzed manually, interpreted in percentages and cross –checked with Microsoft Excel results.

RESULTS AND DISCUSSION

The researchers gathered information from 150 guardians of children and the response rate was 96%. Relating to the demographic characteristics of the sample, the majority of children (70%) were male which showed that they were the higher risk group for accidents than the girls, based on the admission rate throughout the study period. The sample consisted of guardians of children in the ages range of one year to twelve years and 75% of them were living in urban areas.

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Considering the educational level of the caregiver, 88% guardians were able to read and write and the greater part (68%) of the family income of the sample varied from Rupees 10,000 to 30,000 per month (Table -1).

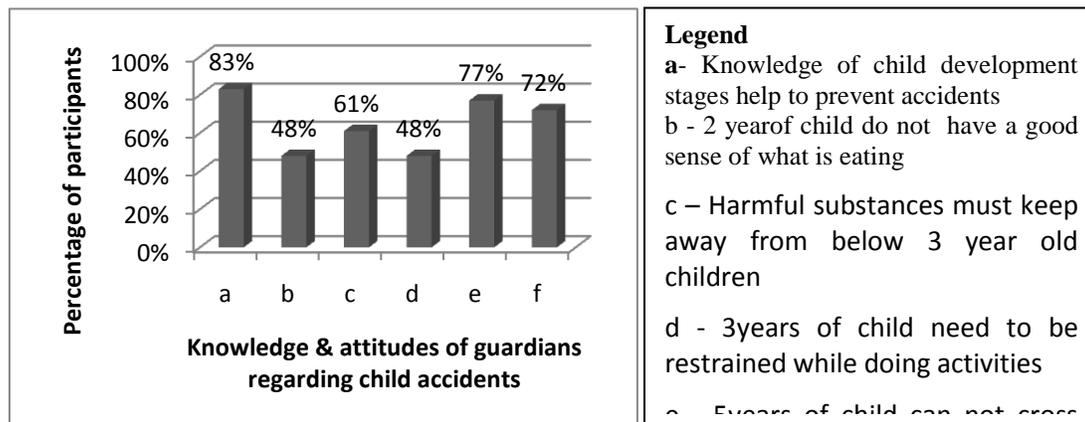
Table - 1: Profile of the study group.

Characteristics	Percentage	Characteristics	Percentage
<u>Sex Living area</u>			
Male	70%	Urban	75%
Female	30%	Rural	25%
<u>Age group (Years) Family income (Rupees/month)</u>			
8 – 12	31%	> 30000	16%
5 - 8	27%	20000 -30000	49%
3 - 5	21%	10000 -20000	19%
1 – 3	21%	< 10000	14%
<u>Educational level of the guardian</u>			
Cannot read and write	12%		
Grade 1 – Grade 9	25%		
G.C.E. Ordinary Level	37%		
G.C.E. Advanced Level	23%		
Degree holders	03%		

In view of the knowledge and attitudes regarding child accidents, a majority of the guardians had more than 50% knowledge and attitudes about accidents. Most of the guardians had known that active supervision of their children is needed to prevent accidents and guardians had taken preventive measures to safeguard children according to their knowledge level. But most guardians had not known that the childhood injuries are a leading cause of death. A majority of guardians (83%) had knowledge about developmental stages which can help to prevent accidents whereas a few did not and they were not even aware of the accidents that could occur in relation to child developmental stages.

Most of the participants (72%) knew that drowning in children usually occurs in unsafe swimming areas; 77% knew that a five year old child cannot cross the street without supervision and 61% knew harmful substances needed to be kept away from children below 3years. Less than 50% of participants knew that a three year old child needed to be restrained when they are doing

activities and that two year old children do not have a good sense of what they are eating.(Figure -1).



Legend
 a- Knowledge of child development stages help to prevent accidents
 b - 2 yearof child do not have a good sense of what is eating
 c – Harmful substances must keep away from below 3 year old children
 d - 3years of child need to be restrained while doing activities
 e - 5years of child can not cross

Figure – 1: Knowledge and attitudes of guardians regarding child accidents

Looking into the causes related to accidents of children, 71% subjects had faced accidents by falling, 11% children had faced road traffic accidents whereas 9% had cut injuries. 5% reported animal bites, 4% were other causes including knocking, swallowing foreign bodies, hitting by objects and assaulting.

When the accident occurred, 85% children had stayed with one parent, and 15% of children had stayed with either parents or another person. 56% accidents had occurred in the home environment while 44% accidents had occurred in other places including the schools and road (Table – 2).

Table -2: Causes and risk factors related to accidents of children.

Characteristics	Percentage	Characteristics	Percentage
<u>Causes:</u>		<u>When accident occurred child was with:</u>	
Falls	71%	Mother	70%
Road traffic	11%	Father	15%
Cut injuries	09%	Both father & mother	05%
Animal bites	05%	Relation	06%
Others	04%	Servant	01%
		Day care	03%
<u>Place of accident:</u>			
Home environment	56%		
Other places	44%		

In identifying the barriers in preventing accidents among children, respondents selected more than one response as barriers to control accidents. Not spending enough time with children was rated as the highest (72%) barrier in preventing accidents. The difficulties in changing the risk

environment (66%), the lack of knowledge in ways of preventing accidents (62%) were also highlighted by the participants as barriers. The two other obstacles to preventing accidents among children, namely impact of cultural norms and values for caring children and the inability to buy higher cost safety equipment were rated as 35% and 25% respectively. (Figure- 2).

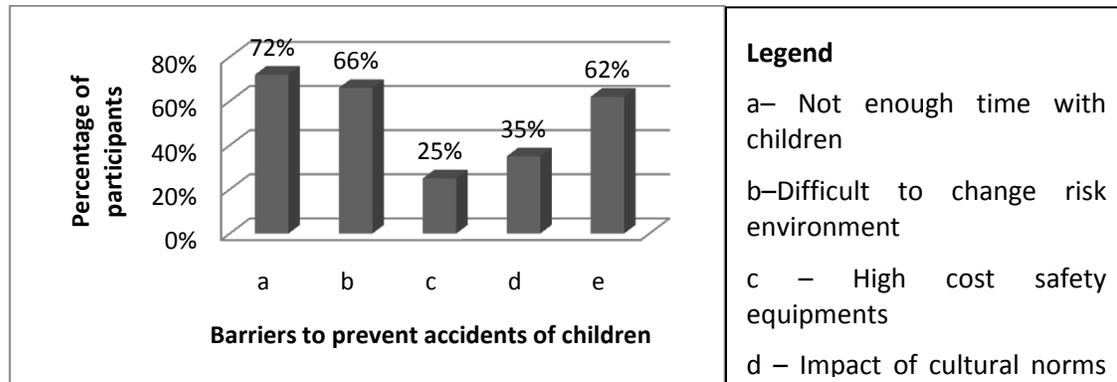


Figure – 2: Barriers to prevent the accidents of children.

CONCLUSIONS / RECOMMENDATIONS

The findings show that, falls were the most common cause for accidents among children admitted to the Lady Ridgway Hospital during the period of the study. The major risk factors related to children's accidents indicate that being a male child, living with one parent or guardian, an unsafe living environment and lack of knowledge increase the frequency of accidents among children. The major barrier for preventing accidents was not enough time to supervise the children constantly.

To overcome the barriers in decreasing risk factors related to accidents it is suggested that the guardians' knowledge be increased and that overall public awareness should also be developed. Further, more research needs to be conducted in recognizing risk factors for accidents among children including both intentional and unintentional accidents as a means of identifying preventive measures which could be applicable in any setting such as home, school, rural and urban or even on the road.

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THE STUDY ON EFFECTIVENESS OF FREE HEALTH SERVICE IN SRI LANKA

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INTRODUCTION

Better health is the basis of human happiness and well-being. It also makes an important contribution to economic progress, as healthy populations live longer, are more productive, and save more (Carr D, 2004). Health services include all services dealing with the diagnosis and treatment of disease, or the promotion, maintenance and restoration of health. Health care consists of primary secondary and tertiary health care.

Sri Lanka is expected to cover the health expenditure with no “out of pocket” share as a mode of allocation. Public health expenditure consists of recurrent and capital spending from government (central and local) budgets, external borrowings and grants (including donations from international agencies and nongovernmental organizations), and social health insurance funds. (Abeykoon P, 2002)

The gap of public health expenditure and the total health expenditure shows the problem of sustainability of free health. This gap has created several problems for patients who visit the government hospitals for their healthcare needs and health development in the community.

This study is basically aims to delineate the disparity of the health policy by identifying the obstacles to obtain free healthcare facilities, health financing issues and the problems related to the disparity of health policy and healthcare services. It aims to clarify with evidence, the circulation of an additional amount of money in the health service sector other than public health expenditure, which creates problems in free health service.

METHODOLOGY

This research was designed with a focus on both primary and secondary data. Respondents from the Western Province were taken as the sample of this study. It was random sampling based on who visited the outpatient department at the national hospital Sri Lanka, base hospital Gampaha and general hospital Kalutara. The estimated sample size was 120 but the actual sample size was 105 as some questioners were rejected due to incomplete answering for more than 50% questions. People over 20 were randomly selected with no gender bias. The Western province is the most densely populated province and economical, educational and cultural variation are high while having both government and private healthcare systems have been established in competitive level. A questionnaire with 16 questions was the primary data collection instrument of this research. It covered the sample profile of the research, relationship between obstacles and moving towards private sector, individual share of health expenditure, utility of government and private sector health care services, awareness and attention on current trends of health and aptitude on health service.

Secondary data were collected from Annual reports, country reports and statistical reports available in data bases were used as a part of this research to interpret the underlying health issues of this issue and results of primary data analysis. Statistical data available in World Health

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Organization (WHO) and Ministry of Health reports were used to ensure the reliability and responsibility of the resource.

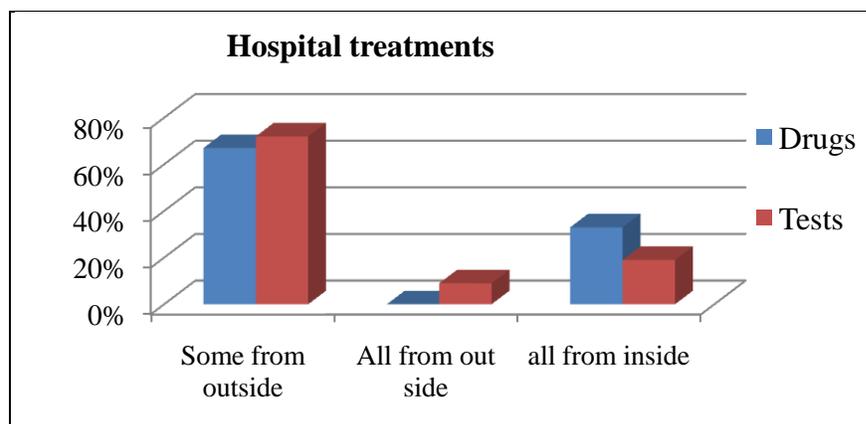
RESULTS AND DISCUSSION

The primary data represents 70% of males and 30% of females. Though it does not represent the actual gender distribution of the country it represents the scenario of the majority of males heading household. In this survey 21% of the sample population was less than 35 years and majority (56%) was in between 35 and 55 years. The other 23% was more than 55 years. It represents the normal distribution of occupational status of the country. The Private sector occupied proportion was 40%. Occupation in the Government sector was represented by 34% of sample population. The majority of the sample population represents a suburban lifestyle.

The survey was designed with a focus on four income levels. A monthly income of less than Rs. 30,000.00 was considered as the lowest income level and an income less than Rs. 50,000.00 was the second level of income. The third level represents the population with less than Rs. 100,000.00 monthly income and income more than Rs. 100,000.00 was considered as the fourth level.

Only 74 respondents (70%) had previous hospitalization experience. Out of this, 47% have been admitted to government hospitals and 24% have both government and private hospital experiences. The other 29% have only experienced the private sector.

The majority of government hospital admitted patients (72%) were asked to bring some drugs from outside. It indicates that the government hospital does not have adequate drugs to treat patients with urgent need. Further, only 28% of patients were facilitated with all the laboratory investigations inside the hospital. All the tests were outsourced for 15% of patients admitted, while 57% of patients were requested to get some tests outsourced. The total amount of outsourced laboratory tests for patients admitted is 72% (Figure 1).



Source: Survey data 2013 for the research

Figure 1: Utility of health sectors by different income levels of the population

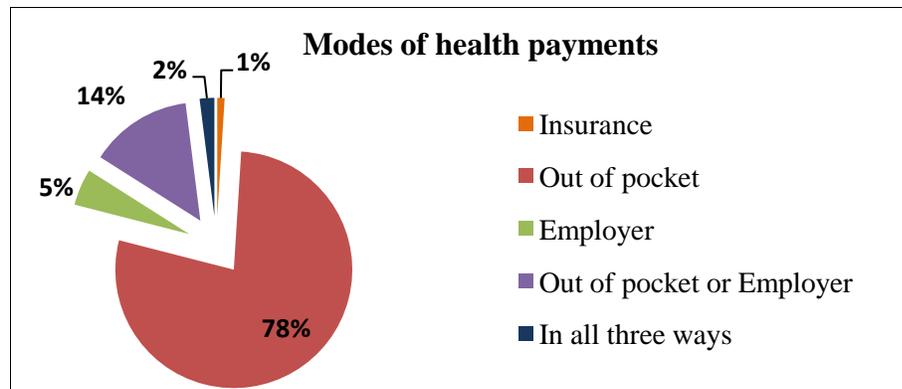
The reasons for moving towards private sector healthcare facilities are long waiting lists at the government hospitals (41%), unavailability of required facilities (24%), the problem of credibility at government health care services (17%) and because expenses are paid by external party for private sector charges (12%).

Out of the respondents, (51%) with non communicable diseases (NCD) were assessed for treatment process. Only 59% were having regular treatment and 28% are utilizing government

facilities for NCD treatments. Private sector was utilized by 38% of respondents. Both government and private sector were utilized by 34% of respondents. This indicates that nearly 50% of population with NCDs moves towards private healthcare, highlighting inadequate care and facilities in government healthcare system.

Only 15% utilizes the government health service as their exclusive service provider. The majority (77%) of respondents utilize both government and private sectors for their curative healthcare needs. Totally private sector is utilized by 12% of respondents. Information from primary data reveals that every person spends at least 1,000 rupees monthly for their health needs. 21% of the sample population spends more than 4,000 rupees monthly for their health needs. Survey data showed that the government hospital is popular among the lower income population. When income level increases people move towards the private sector.

Figure 2 shows the modes of payment who utilize the private health care services. Most of them (78%) pay their expenditure out of their own pocket. This includes low income levels as well.

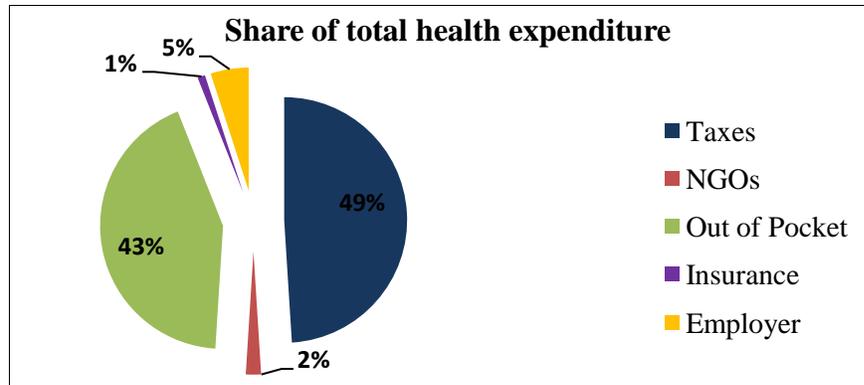


Source: Survey data 2013 for the research

Figure 2: Mode of payments for health

According to the Sri Lanka National Health accounts 2000-2002 (2005), the government maintains health care expenditures at 8% to 10% of total public outlays. Throughout the 1990s, the total health expenditure in Sri Lanka was 3.1% to 3.5% of Gross domestic product (GDP) with government and private sectors taking almost equal shares.

US Global Health policy has ranked countries according to GDP contribution for health expenditure. According to that Sri Lanka is in 115th position and it is at a lower position than most other countries with free health care service. The position of Sri Lanka shows that the country spends a low percentage of GDP; less than many countries like Japan, Bhutan, Thailand and Maldives *etc.*, where there do not have free health service.



Source: WHO, 2009

Figure 3: Share of total health expenditure

Only 51% of total health expenditure is borne by government funds and NGO/other donations. Around 5% of the expenditure is financed by employer's health insurance schemes and 44% of the total health expenditure is financed by out-of-pocket payments or household expenditure (Figure 3). Only 01% is financed by social health insurance like organized health management systems (WHO, 2009).

National Health Accounts 1990-2006 (2009) illustrates the percentage GDP of total budget allocation. It clearly shows the decline of total health expenditure (% of GDP) annually since 2005. It shows the estimated growth of health expenditure from 2001 to 2015. It indicates developing gap of total health expenditure and public health expenditure creating challenging issue on free health. Public health expenditure is always less than 50% of total health expenditure during last 15 years.

From primary data it was evident almost all citizen spends some amount of money for health. Government facilities are inadequate to some extent for provision of health care facilities for all citizens according to their health needs.

Secondary data analysis could justify the present situation of the country's healthcare system. Public health expenditure share of total health expenditure is always less than 50%. (www.indexmundi.com).

CONCLUSIONS AND RECOMMENDATIONS

The research demonstrates that all income levels of the society utilize the private sector for their health care needs. Most of the people who utilize the private sector pay their bills out of their own pocket. The findings reveal the disparity between a free health policy and the nature of the prevailing health care service. This situation has created a massive complication in making policy decisions with an under-strengthened economy whilst the community looks for free health service.

A few recommendations can be made from this analysis. If we expect to continue free health policy further, the total health expenditure should be covered totally by the GDP or with GDP and other funding systems. Furthermore, the amount of total health expenditure which can be covered by above systems should be analyzed as a percentage and it should be provided according to the income level giving priority to the poorest population and others to be facilitated by introducing an insurance system or the percentage of health expenditure which can be covered by GDP or other funding can be utilized for prioritized specific health needs of the country without regarding income levels and people can be facilitated with insurance scheme for other health needs.

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FACTORS INFLUENCING LOW BIRTH WEIGHT AMONG BABIES BORN IN THE TEACHING HOSPITAL ANURADHAPURA: A PRELIMINARY STUDY

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INTRODUCTION

Low Birth Weight (LBW) is a major determinant of mortality, morbidity and disability during infancy and childhood, also having a long term impact on health outcomes once adulthood is attained (Francis, *et al.*, 2010). World Health Organization (WHO, 2011) defined LBW as a condition where the weight at birth of a baby is less than 2500gm (5.5 pounds). According to Pallewatta (1998), maternal age below 20 years and over 35 years, occupational factors like heavy work, low maternal education, low income and maternal nutritional factors are associated with LBW. Siza (2008) found that the Pregnancy Induced Hypertension (PIH), Premature Rupture of Membranes (PROM), placenta preva, abruption of placenta and gestational age below 37 weeks contribute to LBW. Further, the pre-existing medical conditions such as anemia, malaria and inadequate antenatal care are also found to have a relationship with LBW.

Jammeh, *et al.*, (2011) described that more than 95 % of the LBW babies are born in developing countries. In Sri Lanka, as a developing country, the LBW rate was 17.6 per 100 live births in 2008 and LBW rate of North Central Province (NCP) was 14.3 % in 2008 (Ministry of Healthcare and Nutrition, 2008). According to the hospital statistics, out of 11,560 live births, 1966 births were found of having LBW in the year 2011 in the Anuradhapura District (Personal communication, RDHS office). Therefore the main purpose of this study is to examine the factors influencing LBW in babies born in the Teaching Hospital Anuradhapura (THA) and the specific objectives are to assess socio-economic factors, obstetric factors, pre-existing medical conditions and antenatal care received during pregnancy influencing LBW of babies.

METHODOLOGY

Quantitative, descriptive design was used for the study to assess a purposive sample of 133 mothers who delivered LBW babies at post natal wards in the THA. A self administered questionnaire was used as the tool to assess demographic data, socio-economic data, obstetric data, data on pre-existing medical conditions and antenatal care received during pregnancy of mothers having LBW babies. Content validity of the instrument was assured by referring to the standard literature and the subject experts. Reliability and understandability was assured by performing test-pretest reliability. Ethical clearance was granted from the Research and Ethics Committee of Rajarata University of Sri Lanka. Voluntary written informed consent was obtained from each participant prior to the study.

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RESULTS AND DISCUSSION

For the study, 133 participants were recruited and the response rate was 97.8% (127). Majority of the sample (28.3%) belonged to 26-30 years age group and 18.1% belonged to 15-19 years age group. Of the sample, majority (96.9%) was married, 78% was Sinhalese and 68.5% was Buddhist. According to the findings of the study, majority (53.5%) had school education only up to grade 5 hence it might be influencing LBW. This idea was supported by Siza (2008) who suggests that mothers without formal education were four times more likely to give birth to a LBW baby than those who had attained higher education. Pallewatte (1998) also found that maternal education up to primary or no schooling had a significant effect on LBW.

With regard to occupational status of the sample, majority (58.3%;74) was unemployed and the greater proportion (52.8%;67) belonged to low income group which is below 5000 Rupees per month. Viengsakhone, *et al.*, (2010) and Pallewatte (1998) highlighted that the low income level and low socio-economic status have significant association with LBW. Of the employed category, 26 % (33) was engaged in agricultural work in which usually involves hard physical labour. The majority (58.3%;74) was moderate workers while 26% (33) were heavy workers. Pallewatte (1998) also showed that occupational factors like heavy work increase the risk of LBW as it may retard the fetal growth. Moreover, the prevalence of exposure to smoking at home was 35% (43) in this study which may be a significant factor influencing LBW. Wadi and Al-Sharbatti (2011) found that the birth weight had a significant inverse correlation with the maternal exposure to passive smoking.

Table 1. Existing obstetric factors and Pre-existing medical conditions influencing LBW.

Factors influencing LBW	N	%	Factors influencing LBW	N	%
Existing obstetric factors			Medical conditions during pregnancy		
Parity			PIH	13	10.2%
Primiparous	55	43.3%	Pre-eclampsia	07	5.5%
Multiparous	72	56.7%	Eclampsia	01	0.8%
Previous LBW Babies			Gestational Diabetes	03	2.4%
Yes	28	22.1%	APH	15	11.8%
No	99	78.0%	PROM	22	17.3%
Previous miscarriages			Pre-existing medical conditions		
Yes	22	17.3%	Anemia	06	4.7%
No	105	82.7%			
POA at delivery					
28-37 weeks	41	32.3%			
37-40 weeks	81	63.8%			
Above 40 week	05	4.0%			
Multiple Pregnancy	07	5.5%			

N= Frequency; %= Percentage; POA= Period of Amenorrhea; PIH= Pregnancy Induced Hypertension; APH= Ante Partum Hemorrhage

The study shows that 22.1% of mothers had a history of having LBW babies previously and 17.3% had previous miscarriages. Of the sample, 43.3% was primiparous and 56.7% was multiparous (Table 1). These findings were supported by Jammeh *et al.*, (2011) indicating that parity, history of having LBW babies previously and history of having previous miscarriages as the factors affecting LBW babies. According to the findings, 32.3% mothers delivered their babies between 28-37 weeks of gestation which is pre-term (Table 1). Odendaal, *et al.*, (1997) found a

significant association between preterm delivery and LBW. According to the findings of the study, all participants with multiple gestations (7) delivered LBW babies and the medical conditions that were affected to LBW were Pregnancy Induced Hypertension (PIH)(10.2%), Ante Partum Hemorrhage (APH) (11.8%)and Premature Rupture of Membranes (PROM) (17.3%) (Table1).

When considering pre-existing medical conditions,4.7%participants were anemic during pregnancy and they all have delivered LBW babies (Table 1). Findings of Ugwuja, *et al.*, (2011)and Siza (2008) reported that anemia and iron deficiency has major impact on LBW. Concerning the antenatal care received by mothers, 80.3%(102) had received “Thripasha” and 88.2%(112) had received vitamins and mineral supplementations. Of the sample, 42.6% (54) had their “booking visit”(first clinic visit) before 12 weeks of gestation while the majority (57.4%;73)had it after12 weeks of gestation. Tayie and Lartey (2008) reported that the pregnant mothers who sought antenatal care before the end of the third month (before 12 weeks) had average of 3.2 times better chance of giving birth to a normal weight infant. They further stated that pregnant women who received multivitamins and mineral supplementations for more than 5 months had infants whose weight was better than those who receive them for a lesser duration.

Poor attendance at clinics was found problematic in this study as it was reported as 66.9%(85) up to 28 weeks of gestation, 65.1% (56) between 28- 36 weeks of gestation and 51.2% (44) between 36 weeks of gestation to delivery. Zeleka, *et al.*, (2012) found that each antenatal follow-up clinic visit contributed to 21% reduction of the risk of LBW and Siza (2008) found a statistical significance between those who received antenatal care and those who did not. Tan and Yeo (2009) found that adequate maternal weight, height and BMI had a positive influence on birth weight of babies and in this study also 37.8% (48) had inadequate Body Mass Index (BMI is below 18 kg/m²)which is considerable.

CONCLUSIONS/RECOMMENDATIONS

The findings of the study suggests that demographic factors such as maternal age below 18 years, socio economic factors such as low educational level, low income level, hard physical activities during pregnancy and passive smoking affect LBW. With regard to obstetric factors influencing LBW, having a pre-term birth, APH, PROM, PIH, multiple gestation and parity seemed to be significant. Maternal anemia significantly influenced the inhibition of fetal growth potential which is a pre-existing medical condition affecting LBW. Poor antenatal care received during pregnancy such as late booking visits and inadequate subsequent clinic visits, anthropometric differences in maternal physical structure which determine BMI also affected LBW.

The findings of the study can be implicated in maternity care in nursing practice as it can be used to enhance the current knowledge of health care providers especially through nursing and midwifery education. Further the findings would be useful in enhancing the knowledge of expecting mothers aiming to prevent LBW in NCP. As this study was limited to NCP only, the researchers recommend further studies in other provinces that will be beneficial in minimizing LBW in Sri Lanka.

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AN OVERVIEW OF DIABETIC FOOT ULCER DISEASE AT COLOMBO SOUTH TEACHING HOSPITAL: A PRELIMINARY STUDY

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INTRODUCTION

A rapid growth of the prevalence of diabetes mellitus (DM) has been reported in Sri Lanka in the past decades with one in five adults having either diabetes or pre diabetes and one third of those with diabetes remaining under diagnosed (Katulanda *et al.* 2008). DM eventually leads to chronic complications and a significant proportion of patients with type 2 diabetes have complications by the time of diagnosis. Whilst various factors are known to contribute to chronic complications of DM, the duration of DM, the degree of hyperglycaemia, hypertension, dyslipidemia and smoking have been identified as the strongest risk factors.

Among complications, diabetic ulcer disease is a major source of morbidity and the commonest cause of hospital admissions in diabetic patients in the western world as well and in the South Asian region. Ulceration, infection, gangrene and amputation are important complications of the disease which leads to long hospital stay imposing a significant burden on the health budget of the country. Various factors such as prolonged hyperglycemia, distal peripheral neuropathy (DPN), peripheral vascular disease (PVD), foot trauma, walking barefoot and inappropriate footwear have been documented to be associated with foot ulceration.

Ulcer healing is influenced by various factors such as the overall glycaemic control, the presence or absence of infection and/or ischemia, and proper wound care management. Optimum glycaemic control is achieved through proper control of diet and the use of oral hypoglycemic drugs and/or insulin. Appropriate wound care management which involves wound debridement, antibiotic therapy and the use of various types of dressings also enables ulcer healing, preventing possible limb amputations. However, we have observed that current practices on managing patients with diabetic ulcers vary widely in our hospitals and available local literature is very limited regarding this aspect. Hence, our aim was to study a cohort of patients attending the out patients' department (OPD) of a teaching hospital to identify the socio demographic characteristics, life style factors, ulcer characteristics and, diabetic and ulcer management practices of local patients with a view to obtain baseline data required to plan a larger study.

METHODOLOGY

This cross sectional descriptive study examined 88 DM patients with foot and leg ulcers presenting consecutively to the OPD of the Colombo South Teaching Hospital. Previously diagnosed DM patients were identified and the diagnosis was confirmed by medical records. Subjects were recruited on a voluntary basis and written consent was obtained. The study was approved by the Ethics review committees of the University of Sri Jayewardenepura and Colombo South Teaching Hospital.

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Type 2 DM patients with leg and foot ulcers, with ulcer size not less than 2.5cm² and ulcer duration not less than one week and not more than 6 months were included in the study. Subjects with cognitive impairment were excluded. Data on socio demographic factors and diabetic and life style factors (duration of DM, type of DM treatment, history of smoking and alcohol consumption, walking habits and type of footwear, cause of ulcer and presence of co-morbidities) were collected by an interviewer administered questionnaire. Data on fasting blood glucose level, hemoglobin percentage and type of materials used for wound dressing were obtained from medical records. Systolic and diastolic blood pressure measurements were recorded. The foot was examined for the site of ulcer, presence or absence of foot pulses and the presence of varicose veins. Presence of DPN was assessed by 5.7/10g Semmes-Weinstein (SW) monofilament test. The results were analyzed by descriptive statistical methods including frequency percentages, means and standard deviations using statistical package for social sciences (SPSS) software (Version 19).

RESULTS AND DISCUSSION

Table 1: Co- morbidities of patients with diabetic ulcers

Category	Yes (%)	No (%)
Hypertension	35 (39.8%)	53 (60.2%)
Visual impairment	41 (46.6%)	47 (53.4%)
Heart disease	8 (9.1%)	80 (90.9%)
Stroke	6(6.8%)	82 (93.2%)
Kidney disease	7 (8.0%)	81 (92.0%)
Joint disease	4 (4.5%)	84 (95.5%)
Others	9 (10.2%)	79 (89.8%)

Foot ulceration is a costly but preventable complication of DM. A total of 88 subjects were studied. There were 43 males and 45 females. The mean age of the patients was 56.5±10.2 years. The mean duration since diagnosis of DM in our study sample was 8.5±6.9 years while developed countries reported longer durations (USA - 13.2 years, McNelly *et al.*, 1995). This variation might be due to the difference in quality of diabetic care available for the people in developed settings which have led to the possible delay in the onset of ulcer formation. Poor glycaemic control is a well-documented factor which not only triggers diabetic foot problems (Nyamuet *et al.* 2003; 2012; Edo *et al.* 2013) but impair healing of existing ulcers. The mean fasting plasma glucose in our cohort of patients was 137.4 ± 41.9 mg/dl with most showing values higher than the WHO defined normal cutoff of 110mg/dl. Although estimation of glycosylated haemoglobin (HbA_{1c}) is a better indicator to assess the glycaemic control, we had to rely on fasting plasma glucose levels as HbA_{1c} values were not available in all patients.

Cigarette smoking is another associated factor reported for ulcer formation in DM patients (Shahiet *et al.* 2012). Smoking is a known cause of PVD which reduces the arterial blood flow to the lower extremities which in turn increases the risk of foot ulceration and delay in wound healing. All females in this study (n=45) have not smoked nor consumed alcohol. Majority of males have smoked (76.7%) and consumed alcohol (80%). However surprisingly, male to female ratio in the diabetic ulcer population studied was almost 1:1 indicating that the ulcer risk should be thought about even in non-smokers. Foot trauma accounted for the formation of ulcers in 76.1% patients we studied, while remaining had developed ulcers spontaneously. In most instances, the history of

trauma was related to walking barefoot. Ill-fitting and un-protective shoes, occupational injuries and dog bites were the common causes for traumatic ulcers. Although present study found relatively low occurrence of spontaneous ulcers, other recent studies (Shahiet *al.* 2012; Edo *et al.* 2013) have documented about 50% evolving as spontaneous blisters. Uncontrolled hyperglycaemia was thought to be the main factor leading to formation of blisters that subsequently progressed to ulcers. When walking habits were assessed in our study sample we found that although majority of patients used footwear (96.6%, n=85), only 9.4% (8/85) wore appropriate footwear to protect the feet from trauma. Also, it was found that the majority in the group used footwear only for outdoor activities. Since walking barefoot (Jayasingheet *al.*, 2007) and use of ill-fitting and inappropriate foot wear (Nyamu *et al.*, 2003) increase the risk of foot ulceration, use of appropriate footwear and wearing them indoors as well as outdoors should be recommended in patients with DM to prevent foot ulcers.

In our study sample, ulcers were commoner in the foot (86.4%) than in the leg (13.6%). The most predominant ulcer site was forefoot (46.6%), followed by mid foot (21.6%), ankle (10.2%) and hind foot (8%). This finding is consistent with the findings of a Tanzanian study (Chalya *et al.*, 2011) that reported a high occurrence of forefoot ulcers (60.3%). DPN and PVD are the two most important aetiological factors for ulcer formation in DM patients. Previous studies have shown that neuropathic ulcers were common in plantar surface of the foot especially in metatarsal heads while ischemic ulcers were common in extremities of the toes, heels, and between the toes (Bruttocoa, 2010). Leg ulcers are mainly caused by venous stasis and primarily found on the inner part of the leg, just above the ankle. PVD mainly affects the tibial and peroneal arteries of the lower limb. PVD caused by prolonged hyperglycemia, contributes to decrease in endothelium-derived vasodilators resulting in constricting arterial lumen leading to diminished blood flow to the foot. It may cause ischemia of the skin and subcutaneous tissues which might lead to ulceration and delay in ulcer healing. Though Doppler ultrasound is the gold standard to assess blood flow in arteries, we had to limit our examination to palpation of foot pulses. Posterior tibial and dorsalispedis pulses were absent in 9.4% and 10.5% subjects respectively. Nerve damage in DPN occurs in diabetes when blood sugar is poorly controlled for a prolonged period of time. Absence of pressure sensation detected by abnormal SW monofilament test (criterion ≥ 1 insensate site) were reported in 67 % (n=59) of subjects indicating that majority of our patients have insensate feet. When the sensation of the foot is impaired, the patient becomes unaware of the beginning of an ulcer or progression of an ulcer. It also alters the microcirculation of the foot, resulting in reduced blood flow to the foot which delays wound healing.

Table 1 shows the presence of co-morbidities in patients with leg and foot ulcers. The most predominant co-morbidities in our study population were visual impairment 46.6 % (n=41) and hypertension 39.8 % (n=35). Visual impairment may be due to the normal aging process, cataract or retinopathy which may possibly increase the likelihood for foot trauma. High prevalence of hypertension shown in the present study is consistent with other similar studies. It is recognized as a contributory factor for foot ulceration due to its effect on the increased occurrence of PVD in patients with DM. PVD resulting in ischemia in the lower extremities may increase the ulcer risk and impediment in healing the ulcers.

Management of diabetic ulcers requires achieving good glycaemic control and the local treatment of the ulcer pay. Majority of subjects in this study were treated with oral hypoglycemic agents (OHA) alone (n= 52, 59.1 %). OHA and insulin were used in 27.3% while insulin was administered in 5.5% of the subjects. DM was controlled with diet alone in 8.0%. Combination of both OHA and insulin has been reported to have favorable outcomes on glycaemic control when compared to treatment with oral drugs alone (Rafiqet *al.*, 2008). Various types of dressing material were used for management of ulcers with the common wound dressing material being

povidone iodine (Betadine) 51.1 % (n=45) followed by Metronidazole (Metrogel) 25% (n=22) and iodisorb powder 8% (n=7). Povidoneiodine is bactericidal with maximal activity at 0.1% - 1%. Although some studies have shown inconclusive evidences for using povidone-iodine solution for managing wounds (Burks, 1998), a recent study has observed it being less advantageous over superoxidised solution (Kapur&Marwaha, 2011). However, conventional wound dressing materials seem to be still popular in our government hospital setting probably due to less cost. Certain iodine preparations (eg: iodisorb powder) are useful in absorbing exudates of ulcers and preventing skin excoriation (Hilton *et al.* 2004) and hence preferable for chronic wounds. Unripe *Carica papaya* was another topical application used for treatment of chronic ulcers in our population. Even though it is not widely used, topical application of papaya is found to be useful in promoting desloughing, granulation, healing and reducing the odor of the wound (Hewitt, *et al.*, 2001).

CONCLUSIONS/RECOMMENDATIONS

Diabetic foot ulceration was seen equally in both sexes with ulcers occurring about 8 years after the diagnosis of DM. The important associations of diabetic ulcers identified in this study are poor glycemic control, impaired foot sensations, reduced foot pulses, impaired vision and hypertension. Foot trauma contributed to ulceration in majority of patients. Although the use of insulin is recommended for good glycemic control which is a prerequisite for ulcer healing, only a minority of patients were treated with insulin. Povidone iodine was found to be the most used wound dressing material in the OPD.

Diabetic foot ulceration has to be thought about in all diabetic patients irrespective of their sex. Optimum glycemic control should be ensured in DM patients to prevent complications. Regular screening for DPN, PVD, vision etc. and patient education regarding appropriate footwear is mandatory to reduce the burden of diabetic ulcers on the health care system of the country and to improve the quality of life of people with diabetes. The suitability of new evidence based ulcer management strategies should be researched in our population.

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AN EXAMINATION OF SELF-CARE PRACTICES AMONG DIABETES MELLITUS PATIENTS IN DIABETIC CLINIC AT THE TEACHING HOSPITAL, PERADENIYA

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INTRODUCTION

Diabetes mellitus is a metabolic disorder which can be controlled through medical treatment and life style modification (WHO 1999). Most of the diabetic patients are treated as out patients, and therefore, they manage the disease at home through self care practices. Self care practices are the personal and medical care performed by the patient usually in collaboration with, and after instruction, by a health care professional to manage their own condition (Dorland's Medical Dictionary, 2007). Looking at the meanings of these definitions together, it is clear that self care practices among diabetic patients play a vital role in successful management of diabetes by reducing the development of complications including heart disease, eye disease, kidney disease and nerve damage.

Health care providers conduct educational interventions for diabetic patients to improve their knowledge and self care practices. Although there were many educational interventions conducted for diabetic patients by the Diabetic Education Centre with diabetic educator nurses in each hospital, and the Foot Examination Centre, recurrent admissions with complications are increasing. Thus the implementation of self-care practices of patients is questionable. Consequently with the intention of understanding why more diabetic patients get admitted to hospitals with complications, this study examined the self care practices among diabetic patients. The general objective is to examine the self care practices used by diabetic mellitus patients who attend the diabetic clinic in the Peradeniya Teaching Hospital. Further, the study was guided by the following specific objectives: identify current self care practices used by diabetic mellitus patients, discuss the barriers faced by diabetic mellitus patients relating to their self care practices and identify the learning needs of diabetic patients.

METHODOLOGY

This is a descriptive study. The target population was diabetes mellitus patients who were diagnosed as diabetic at least for five years duration, above 40 years of age regardless of gender and ethnicity. The study was conducted in the diabetic clinic at the Teaching Hospital, Peradeniya. Women who were pregnant or had gestational diabetes and patients who were taking steroids as lifelong treatment were excluded from the study. A sample size of 200 subjects was selected using Purposive Sampling method. All participants had opportunity to voluntarily participate in the study and they had the freedom to refuse or withdraw from the study at any time. Written informed consent was obtained from all participants. Before the data collection, permission was obtained from the director of the hospital. Ethical approval was obtained from the ethical review committee of the Faculty of Medicine, Peradeniya. A self-administered questionnaire was used as the tool of data collection. All together 40 items were included in the questionnaire under the specific objectives. First part included demographic data; Second part was designed to measure diabetic self care practices on physical exercises, diet, medication, foot care and knowledge of complications. Barriers to adherence of care were assessed in the third section. Fourth section was developed to identify the learning needs of the diabetes mellitus patients. A questionnaire was developed in their respective mother tongue. Questions were orally

explained to subjects who had low literacy levels. Content validity of the questionnaire was assured by referring to text books and taking opinions from subject experts. Finally, necessary modifications were done with the supervisor. Reliability of the questionnaire was assured by pre - testing with a few participants who were not included in the study, but who met the inclusion criteria of the study. Data analysis was done with descriptive statistics and Microsoft Excel software.

RESULTS AND DISCUSSION

A total 186 diabetic patients participated in the study (response rate 93%) of whom 71.92% were female and 27.15% male. Majority of the respondents (88.25%) were from rural areas.

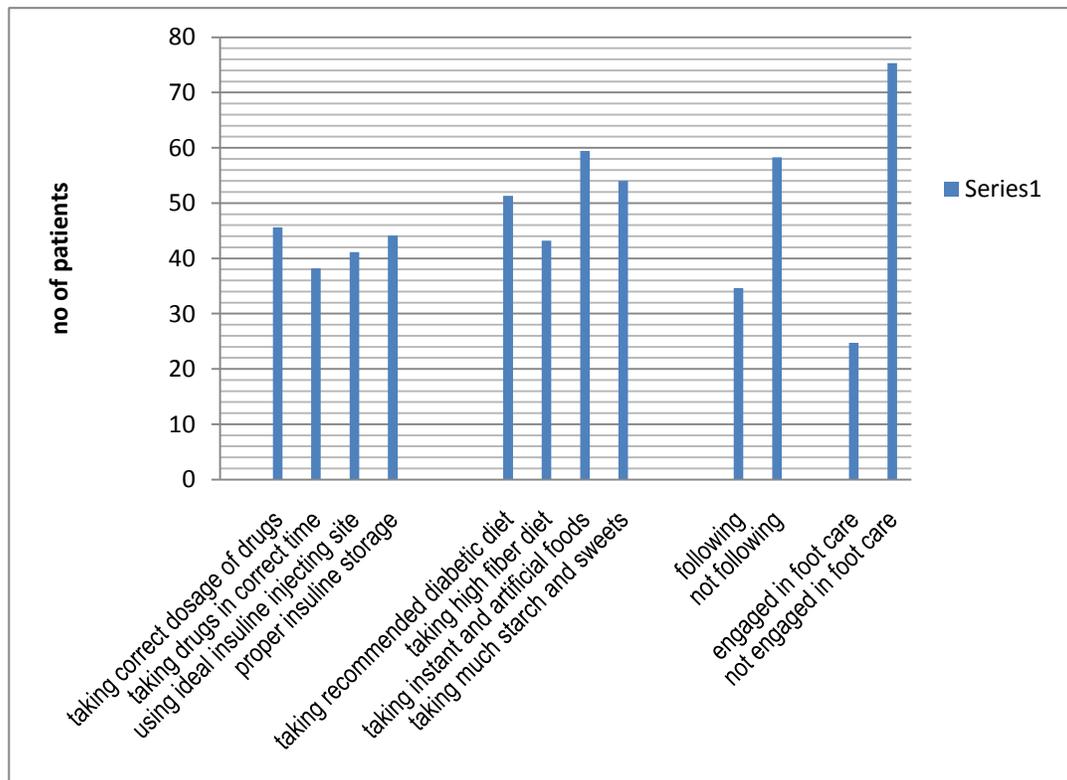


Figure 1. Current self care practices.

Among the participants 59.73%, showed poor drug practices, 56.7% poor dietary practices, and 34.56% followed recommended exercise. Large proportions of them (75.3%) were not engaged in foot care (Fig. 1). According to the present study, most patients were on oral hypoglycemic drugs and diet control. Nevertheless the patients had poor practice in relation to their drug. In the literature, most studies did not observe the knowledge of drug practice among diabetic patients. The present study showed that there was no significant difference relating to dietary practices among participants, similar to the study by Padma *et al.* (2010). Study findings further revealed that although patients had knowledge about their dietary practices, they did not adhere to diet regime accordingly.

In this study, very few patients engaged in physical exercise regularly. This could be due to most participants being females who could be less active than males specially in regular exercise programmes because of household and children activities (Ayele *et al.*, 2012) and (Khattab *et al.*, 2008). The present study revealed that many patients were not aware of early identification and

prevention of diabetic complications. Further, more there were significant difference between the patients who engaged in foot care and those who did not. This was also highlighted by All (2011). In contrast Nwasuruba et al (2007) found that most patients who had better knowledge engaged in foot care.

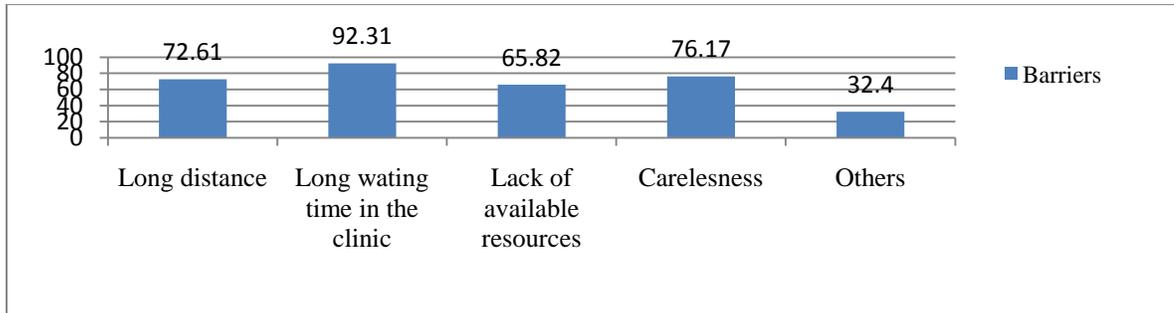


Figure II. Barriers to self care

Participants who had faced long waiting time at the clinics were 92.31%; 72.61% travelled long distance to reach the clinics and carelessness was a barrier for 76.17% patients (Fig. II). According to the study, more than half of the participants faced barriers relating to self-care practices. Most participants faced many barriers when attending the clinic. According to the study, some of them had to travel long distances to reach the clinic while others experienced long waiting time at clinics. Some patients experienced financial constraints when getting prescribed investigations done from the private sector due to lack of laboratory facilities in hospitals and some patients encountered poor family support. According to the study, carelessness is another barrier for lack of self care practice among diabetic patients. The studies of All (2011) and Ayele *et al.* (2012) were also highlighted similar findings.

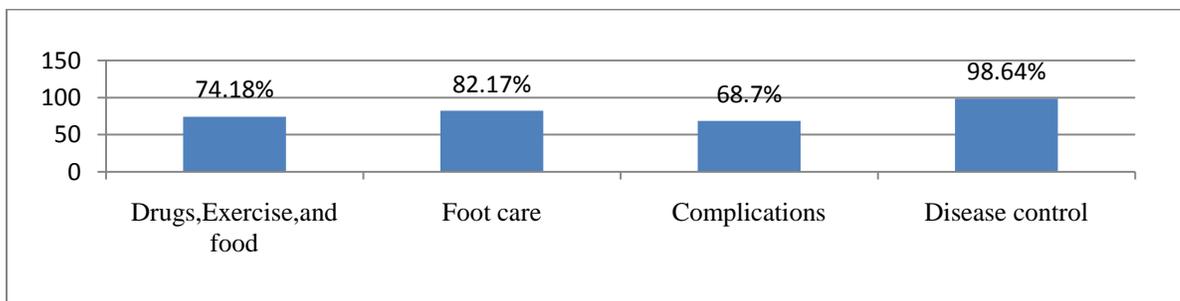


Figure III. Represents the identified areas of learning needs

Of the sample 82.17% needed to learn more about the disease and 98.64% of them preferred to know more about how to control the disease (Fig. III). The study findings revealed that the more frequently identified area of learning need is how to control the disease. A lesser number of participants wanted to know about complications. The previous studies have consistently reported that education has a significant effect on patients with diabetes and self care practices. (Ayele *et al.* 2012, Yeong, 2009).

CONCLUSIONS/RECOMMENDATIONS

The findings of the study have illustrated that there is a clear deficiency in self care practices; drug practices, dietary practices, physical exercises, foot care practices and identification and prevention of complications among patients with diabetes. Yet, a majority of the participants preferred to learn more about how to control of the disease. When exploring barriers for self care, most of the participants reported that they faced barriers when attending the clinic.

Despite receiving education and recognizing the importance of self care practices of diabetes, the participants still had difficulties in putting their knowledge into practice. Ultimately it can be concluded that if the patients are provided with knowledge to suit their level of understanding it might be easy to convince them to follow desired self care practices. Therefore educational programmes have to be implemented based on the patient's learning needs and then self care skills would be a great benefit for them.

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STUDY ON CATARRHAL FEATURES EXPERIENCED BY UNDERGRADUATES IN THE FACULTY OF MEDICAL SCIENCES IN UNIVERSITY OF SRI JAYEWARDENEPURA

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INTRODUCTION

Catarrhal features are a common health problem in society. It is usually considered a mild disease condition in general health care practice and often not managed appropriately. The prevalence of allergic rhinitis is increasing in most countries of the world, and particularly in areas with low or medium levels of prevalence (Bousquet *et al.* 2008). The effects of allergic rhinitis /catarrh on the quality of life of individuals include impairment of day-to-day activities, which may lead to an economic burden (Bousquet *et al.* 2008).

Rhinitis is clinically defined by several common symptoms such as nasal discharge, itchy nose, eyes and palate, sneezing, nasal blockage or congestion and headache. There are three common types of rhinitis allergic, non allergic and infective rhinitis. Rhinitis symptoms can be seasonal (symptoms in peak times during the year) or perennial (year round symptoms). Catarrhal features lasting for less than four days or less than four consecutive weeks are defined as acute catarrhal symptoms and catarrhal features lasting for more than four days or more than four consecutive weeks are defined as chronic catarrhal symptoms

The aim of this study was to describe catarrhal features experienced by undergraduates in the Faculty of Medical Sciences in University of Sri Jayewardenepura.

RESEARCH METHODOLOGY

A descriptive cross sectional study was carried out in the Faculty of Medical Sciences, University of Sri Jayewardenepura, Sri Lanka among 400 participants. The target population comprises all first year (2010/2011 batch) and fourth year (2007/2008 batch) students both male and female undergraduates in the B. Sc Nursing, B. Pharmacy, B. Sc. Medical Laboratory Sciences and Medicine courses. Few undergraduates who were lateral entrants were excluded because of the differences of age compared to direct entry undergraduates.

Data were collected within the first two weeks of October 2012 using a pre- tested self administered questionnaire developed by the investigator according to the 'Allergic rhinitis management pocket reference 2008'.

Data were analyzed using SPSS 16.0 Statistical package.

RESULTS AND DISCUSSION

In the present study, prevalence of participants experiencing catarrhal features was 68% (n=275). Among them 52.7% (n=145) were with perennial catarrhal features and 47.3% (n=130) with seasonal catarrhal features. In this study 73% (n=201) had acute catarrhal features and out of this 54.5% (n=150) were suffering from catarrhal features for a period of less than four days per week and 18.5% (n=51) had catarrhal features for less than four consecutive weeks. Only 26.9% (n=74) participants were suffering from chronic catarrhal features. Out of those 14.9% had symptoms for more than four days per week and 12% had symptoms more than four consecutive weeks

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The prevalence of catarrhal features were comparatively high in the present study when compared with studies conducted in other countries. The prevalence of rhinitis in a study done in South West London community among adults aged 16- 65 years was 24%, consisting of 3% with seasonal symptoms and 13% with perennial symptoms (Sibbald & Rink 1991). In another study done among University students in Pakistan 38% of participants reported to have allergic rhinitis (Ghazal, Musmar and Minawi, 2007).

Among participants with catarrhal features a majority 73% (n=201) had acute catarrhal features. . Most common acute catarrhal features were watery runny nose and sneezing (Table 1). Prevalence of those two was 87.3% (n=240) from all participants with catarrhal features (n=275). Only 26.9% (n=74) participants were suffering from chronic catarrhal features. These results are different from findings of research study conducted in South West London (Sibbald & Rink, 1991).

Table 2: Common catarrhal symptoms experienced by participants

Characteristics	Frequency (n= 275)	Frequency Percentage (% f)
Watery runny nose	240	87.3
Thick green or yellow color discharge from the nose	65	23.6
Sneezing (more at one time	240	87.3
Nasal obstruction		
Only one side of the nose	180	65.4
Both sides of the nose	103	37.4
Nasal itching	140	50.9
Throat itching	180	65.4
Red watery itchy eyes	101	36.7
Itchy ears	108	39.3
Thick mucus flow down the back of throat with runny nose	107	38.9
Thick mucus flow down the back of throat without runny nose	72	26.2
Fullness of throat	65	23.

Persistent throat clearance	85	30.9
Sore throat	132	48.0
Loss of smell	99	36.0
Troublesome cough especially at night	72	26.2
Wheezing	87	31.6
Cough or wheezing after exercise	51	18.5

Table 3: Frequency of impact on daily activities

Characteristics	Frequency (<i>n</i> = 275)	Frequency Percentage (% <i>f</i>)
Sleep disturbances	192	69.8
Impairment of normal daily activities	151	54.9
Disturbances to academic activities		
Concentrating	182	66.2
Attending lectures	68	24.7
Disturbances to sports activities	71	25.8

Table 4: Frequency of predisposing factors

Characteristics	Frequency (<i>f</i>) (<i>n</i> = 275)	Frequency Percentage (% <i>f</i>)
Exposure to dust	223	81.1
Cleaning cob webs	173	62.9
Exposure to grass pollen	107	38.9
Exposure to animal dander	72	26.2
Strong odors	70	25.4
Pollen of flowers	31	11.3

Cigarette smoke	64	23.3
Exposure to air pollutants	120	43.6
Stress due to examinations	118	42.9
Weather changes	199	49.8

Some participants reported catarrhal symptoms associated with asthma 36 % (n= 87), wheezing 31.6% (n=72) and troublesome cough especially at night and 18.5% (n=51). Similar to many studies already conducted, the present study also showed a relationship of asthma and catarrhal features (Bousquet *et al.* 2008). And also according to the table 2 in the present study it was shown that catarrhal features interrupt daily activities and life style of the participants (Bousquet *et al.* 2008).

In the present study common predisposing factors including exposure to house dust (81.1%, n= 223), weather changes (49.8%, n= 199), strong odors 25.4 % (n=70), smoke 23.3%, (n=64) were compatible with findings of study done by Ghazal, Musmar and Minawi, (2007). Prevalence of predisposing factors except strong odors and smoke were considerably high in the present study. Findings of previous study was house dust 46.7%, strong odors 40.6 %, smoke 33.8%, weather changes 34.2%) (Ghazal, Musmar and Minawi, 2007).

CONCLUSION

There is a high prevalence of catarrhal features among undergraduates in Sri Lanka. The prevalence of seasonal catarrhal features and perennial catarrhal features were almost similar (around 50%). Acute features are common but still there is considerable percentage of undergraduates who are suffering from chronic catarrhal features. Symptoms are bothersome and affect negatively for activities of daily living and quality of life. House dust, breaking cob webs, weather changes, grass pollen, strong odors, smoke, air pollutants and stress due to examinations are common triggers for catarrhal features.

Common health problems related to catarrhal features among young adults are described in this study. The findings would be useful in preventing experiencing and exaggerations of symptoms by avoiding predisposing factors. It could also help them to cope with symptoms and motivate them to take early treatment to prevent asthmatic symptoms.

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A STUDY OF ANIMAL BITES AMONG CHILDREN IN LADY RIDGEWAY HOSPITAL

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INTRODUCTION

Animal bites among children is a serious public health problem world wide(Overall and Love 2001 An animal bite .(is a break, tear, bruise or a puncture in the skin from an attack of any kind of animal to a child) Garth,2012). The animal bites to the children can vary from small insects, cats, dogs, monkeys, raccoons, foxes and batsIt leads to . so many health problems such as wound infection, deformities, organ damage, hospitalization and rabies [World Health Organization (WHO),2009].However , previous studies regarding this topic were mainly focused on dog bites, since it can cause so many health problems including rabies) Keuster ,*et al.*, *et al* Rosado ;2006. , 2004Kreisfeld and Harrison ;, *et al* Sudarshan ;2005. ,2006(. At present, approximately 400 000, American children receive *et al* Davis)treatment for dog bites annually . ,2011 .(

statistics and studies on animal bites ,In Sri Lanka have According to .mainly focused on rabies and now it 1973deaths were reported due to rabies in 377 ,(2011)WHO has been reduced up to animal bites were reported 320,000 ,pointed out that (2011)The Ministry of Health .deaths 60-50 persons 43and had detailed studies on animal bites among ,However .2010died from rabies in children area because there ,current need of the society is a lack of studies regarding this topic in this study was designed to ,Therefore .Sri Lanka identify the common animal bites in children which can help to develop preventive methods for such incidence. Specific objectives of this study were assessment of knowledge and attitude of parents regarding this topic that can be used as a tool for developing education programmes. Furthermore, identification of the vulnerable age group for animal bites, which will provide ideas and suggestions to control animal bites in future. Finally, evaluation of the existing health practices in Sri Lanka related to animal bites will explore the gap of current practices.

OGYMETHODOL

Quantitative approach was used for this study and data were collected numerically (Polit and Hungler, 1999). A survey was conducted using the purposive sampling method at Lady Ridgeway Hospital (LRH). The sample consisted of 300 children (age between 01 year to 12 years) who were referred to the Accident Service Unit (ASU) for treatment of animal bites during one month period from 25th December 2012 to 25th January 2013.A close ended self administrative questionnaire was used as a tool for collection of data from the parentsThe .of the victims .Fi .questionnaire was designed in four sectionsrst three sections were designed to identify the vulnerable age group and gender of the children, to gather information related to the animal bites, to identify the knowledge and attitudes of the parents regarding animal bites. These three sections were completed by the guardian of the children. Fourth section was designed to identify the existing health practices in Sri Lanka related to animal bites and rabies which was completed by the researcher. This questionnaire consisted of 23 questions.Data were analysed by using .descriptive statistical analyzing technique

RESULTS AND DISCUSSION

According to the study, gender of the sample (n= 300) mainly affected the animal bites. From the sample, boys proportion was significantly high ($Z = 3.70$, Z at $\alpha = 0.05$ is 1.96) when compared to the girls proportion of the sample. From the sample 60.7% were boys and 39.3% were girls proving that boys were at a higher risk of animal bites than girls. The age of the children significantly affected ($\chi^2 = 20.026 > \chi^2_{0.05,3} = 7.81$) to the animal bites. Findings showed that (Figure 1) when age increased patient numbers decreased, and the most vulnerable age group was 04-06 years (32%). Probably children who are in this age group are more prone to playing outside and they have no comprehension about accidents .

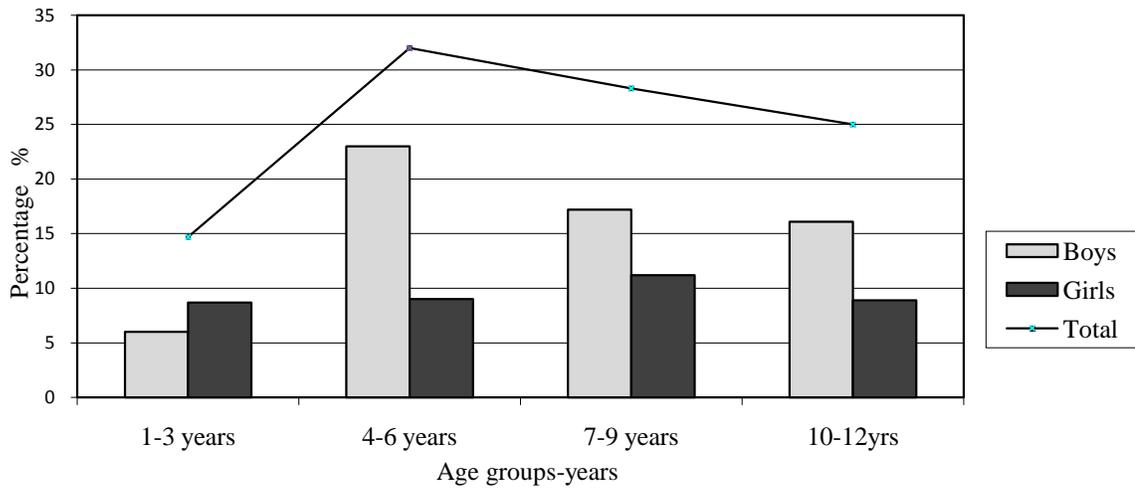


Figure 1 age groups and gender of the different Relationship of animal bites with - sample

According to the study, dog bites were the commonest (69.7%, n= 209) animal bite among the children (Figure 2). From the dog bites proportion, a vast majority of dogs (52%, n= 110) were known dogs and 31% (n=65) were own dogs (Figure 2). These findings confirmed the results of the previous studies, that a huge proportion of animal bites were by dogs and the majority of bites were reported from known dogs (Schalamon *et al.*, 2005; Georges and Adesiyun, 2008; Lang and Klassen, 2005) ,hereforeT .these findings will be a tool to educate parents and dog owners.

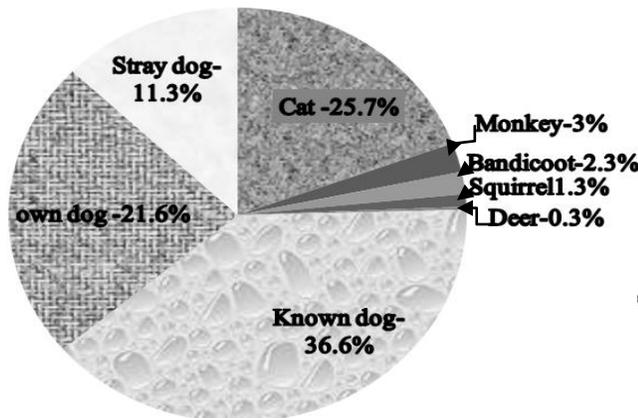


Figure 2 - Identification of common animal bites

Types of the wounds due to dog bites, strengthened previous findings (Georges and Adesiyun, 2008; Lang and Klassen, 2005) since, most of the wounds were reported as superficial wounds (78%). The legs of the children were the most frequently bitten sites (47.6%, n= 141). The majority of victims who had injuries in extremities were caused due to the behavioral patterns of the victims when they were attacked.

According to the study, most of the parents (81%) were aware that animal bites needed immediate treatments and 72.6% knew that it can cause rabies too. A majority (88%) of parents had knowledge that rabies can be prevented by vaccination (76%). Therefore the overall findings of study showed that the knowledge and attitudes of the parents of the children regarding animal the s bites wererat a satisfactory level in Sri Lanka unlike in other countries (Rambhau and Dilip, 2011) .Majority (80.7%) of cases needed only Anti Rabies Vaccine (ARV) and 6% needed both Anti Rabies Serum (ARS) and ARV (Table 1). Thus, it was proved that health practices are well conducted according to the WHO guidelines.

Table -1: Existing health practices for animal bites

Characteristics	Percentage
Type of Wound	
Superficial	78.0%
Multiple	13.7%
Deep	8.3%
Treatment Type	
ARV(Anti Rabies Vaccine)	80.7%
ARS/ARV(Anti Rabies Serum/ Anti Rabies Vaccine)	6.0%
None	13.3%
Suture requirement	3.3%
Yes	96.7%
No	
Antibiotic requirement	66.0%
Yes	34.0%
No	
Hospitalization Period	88.7%
Below 1 day	8.0%
1-2 days	3.5%
Above 3 days	

RECOMMENDATIONS

Dog bites are the commonest type of animal bites among children and children who are between 04-06 years represent the high-risk group for animal attacks. When considering the girls and boys, boys' proportion is the highest risk group. Among the dogs bites, known dogs are more responsible for attacking the children. The verall knowledge and attitude among parents regarding animal bites are at a satisfactory level and existing health practices are also being practicing well, According to the WHO guidelines.

Educational and public awareness programmes should be held on the prevention of animal bites in the community. Awareness programmes should include pet vaccination, caring for pets properly, how to protect children from animal bites, and first aid and treatment after the bite incidents. This study recommends education related to dog bites be added to the school curriculum. Further research in all areas in Sri Lanka should be conducted to identify the real situation relating to animal bites among the public which will be very useful to overcome the present barriers related to the prevention of animal bites island wide.

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MOTHERS' EXPERIENCE OF MATERNITY CARE DURING LABOUR AT THE TEACHING HOSPITAL KANDY

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INTRODUCTION

Motherhood is a complex role and an experience full of responsibilities and varying emotions. The event of labour which gives women motherhood is a physiologic process during which the products of conception are expelled outside of the uterus (American College of Obstetricians and Gynecologists - ACOG, 2003). In this process severe pain occurs and labour pain has been proven to be the most severe of all types of pain (Melzack, *et al.*, 1981).

Pain is expected in labour and cannot always be eliminated. Therefore it is crucial to support the woman to cope with labour pain and is the most important aspect of the nurse's role (Simkin, 2002). Labour support is a term used to describe the work of caring or supporting provided to women during labour by a health care worker (Payant, *et al.*, 2008).

Previous studies pointed out that the mothers' experience about nursing care during labour is dependent on several factors such as way of communication, being informed, allowing to make choices, being involved in the process of the nursing care and mothers' own perceptions of nursing care (Barrett and Stark, 2010; Bianchi and Adams, 2004).

In comparison with other countries, Asian countries have only a few studies in this area and there is little or no published studies found in Sri Lanka. Given the scarcity of available literature, it is necessary to study mothers experience about nursing care during labour. The outcomes of the study would be useful to make nurses aware in labour rooms, enabling them to provide quality care to the mothers who are attuned to normal labour. The main purpose of this study was to examine the mothers' experiences towards nursing care during labour at the Obstetric Units (labour rooms) in the Teaching Hospital, Kandy in Sri Lanka and the specific objectives of the study were to explore mothers' attitudes about nursing care received at the labour room, mothers' expectations of nursing care during labour and mothers' satisfaction with nursing care during labour.

METHODOLOGY

A qualitative research approach is effective in investigating human life experiences (Streubert & Carpenter, 1999). As the researchers of the present study also plan to explore the experiences of participants to understand them through the analysis of subjects' descriptions, qualitative descriptive design was used for the study.

For the study, purposive samples of multiparous mothers were selected from postpartum units of the Teaching Hospital, Kandy. Inclusion criteria to select the sample were ability to read and

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speak Sinhala, have experienced an uncomplicated labour and experienced vaginal delivery during the last four to seven days, have delivered a healthy infant of 37 or more weeks of

gestation, have attended prenatal clinics, belonging to 20-34 years of age group, have been admitted at least six hours before starting the first stage of labour and being multiparous mothers. A sample of 15 mothers was selected from three post natal wards in the Teaching Hospital, Kandy. Ethical approval for the study was granted from the Ethical Committee in the Teaching Hospital, Kandy and prior permission to access the setting was obtained from the director, relevant consultants, special grade nursing officer and sister in charges in the Teaching Hospital, Kandy. Voluntary, written informed consent was obtained from each participant and anonymity, confidentiality and privacy were maintained throughout the study.

Face to face in-depth interview which is one of the self reporting methods was used for collecting data for the study. Open ended questions which were based on the specific objectives of the study were used to direct the interview. Each mother was interviewed for a 45 to 60 minutes period.

The response rate was 100% of this study. Audio tape recorders were used to record the data during the interview to reduce researchers' bias and to maximize the accuracy of the information. Afterwards, the researchers listened to the tape recorders carefully and verbatim transcription was done. Each transcript was read multiple times by the researchers to understand the meanings. Data analysis was done under the specific objectives of the study and care was taken to avoid harm to the original narratives. Coding comments were made, then the codes were clustered to derive the themes. Three interviewers reviewed each transcript in order to come to an agreement on themes and category interpretations. Categories were then revised and compared with the narratives.

RESULTS AND DISCUSSION

The findings were reviewed and analyzed based on the specific objectives of the study; to explore a) mother's attitudes about nursing care during labour, b) mothers' expectations of nurses and nursing care during labour and c) mothers' satisfaction about nursing care during labour.

In exploring mothers' attitudes and beliefs about nursing care during labour, the findings of the study revealed that most of the participants had prejudgments of nurses and nursing care either due to their own previous experiences or due to the influence of others (relatives, friends or neighbors). Among them some attitudes were positive while most were negative. The negative attitudes that they held were identified by the themes derived such as 'nurses are tough', 'nurses get angry easily', 'nurses are not friendly', 'nurses care differently to known persons (discriminate)' and 'nurses are not respecting patients as dignified people'. The themes identified from the positive attitudes they held were 'nurses are friendly', 'nurses are caring' and 'nurses are facilitating'.

Some participants believed that nurses are tough and get angry when patients do not listen to them. One participant reported that "I stayed the way they (nurses) asked me to stay. I did not tell anything. I had discomfort... If I tell it to nurses, they will shout at me. Therefore I bore it". Some of the participants held the attitude that nurses discriminate among patients as they believed that "if patients are known to them (nurses), he or she receives 'special care' by them". Some held negative attitudes assuming that nurses did not respect them as dignified persons as they claimed that they were not welcomed or given orientation to the labour room and were just informed to go to the bed in the labour room by the staff.

According to the findings, some participants replaced the negative attitudes they had previously held about nurses such as ‘nurses are tough’ and ‘get angry easily’ with positive attitudes like nurses are friendly and caring, based on their current experience in the labour room. One participant claimed that “nurses are definitely like Gods. I never expect but they cared me like my parents”. Some negative attitudes were remained still such as ‘nurses care differently to known persons’ and ‘nurses are not respecting patients as dignified persons’.

As revealed from the study results, the themes derived relating to their expectations were receiving of ‘welcome care’, ‘reassurance’, ‘support’, ‘physical comfort’, ‘emotional support’, ‘good communication’ and ‘being physically close’. Bower (2002) also identified ‘emotional support’ as a major expectation of mothers during labour. Further he stated that physical comfort and good communication of caregivers would inspire mothers.

In the current study, mothers did not expect a special or warm welcome from nurses but most of them had a usual welcome. A majority of mothers expected physical comfort, touching and spent time closely with nurses specially when the labour was in progress. One participant verbalized her pleasure as her expectation of physical closeness was fulfilled by saying “actually labour room nurses are very good because they (nurses) stayed close to me until I delivered the baby”. In contrast one of participants (in another labour room) expressed her disappointment as the nurses were not physically with her during the delivery, “nurses were stayed with me a little time, only until putting the belt around my tummy. They did not remain with me adequately, only coming and going”.

Most of the participants had fulfilled their expectation of receiving basic care needs such as receiving foods, water, assistance in toileting, assistance in cleaning whenever they need. These are clearly reflected by the participants’ own voice as follows; “Nurses are good and always supporting. When I asked some water, they gave me a bit of water and explained me that it’s better not to drink too much before the delivery. After the delivery, a nurse gave me a cup of tea and helped me to change my cloths”. But one mother out of 15 was disappointed stating that “after the delivery I felt thirsty. There was no water in the labour room. It was around 9.30 pm and until I leave the labour room I did not receive any thing for my thirsty”.

Communication in a smooth manner was one of the major expectations of mothers during their labour. One participant conveyed her expectation of communication based on her negative experience as “No time for nurses to speak to us”. Another major expectation of mothers was to receive support in relieving labour pain in the labour room and this was clearly voiced by a participant as “they did not do anything to ease my pain; after giving synto, the pain was increased”. Further the mothers expected professional assistance and instructions and guidance during the labour for them to feel secure and comfortable. This expectation was voiced by one participant as “nurses told me to spread the legs apart and urge me to strain. They (nurses) were telling me to strain until the baby was delivered. I obeyed the instructions and the delivery was easier”. One mother expressed her dissatisfaction about this expectation by voicing that “pain was coming continuously. I shouted. Nurses also shouted by telling that baby’s heat rates are coming down. I was scared. It was difficult to take the baby out. Nothing was given to relive my pain”. Finally mothers expected the nurses to take care of their babies.

In relation to the mothers’ level of satisfaction about nursing care during labour, all the mothers seemed satisfied. All the mothers in the study recommended the same place and the facilities for the next time also by stating that “I am happy about the care given by the nurses. Small things normally happen everywhere.... Isn’t it? I didn’t care about that”. Further, most of mothers were

satisfied about physical comfort, instructions during labour, and baby care they received. But they were not very satisfied about the emotional support they received.

CONCLUSIONS/RECOMMENDATIONS

According to the findings, mothers' attitudes about nurses and nursing care during labour showed a relatively positive aspect. Mothers had pre-judgments about nurses and nursing care both positive and negative and with the current experience in the labour room some of their negative attitudes were replaced with positive attitudes. Mothers showed dissatisfaction about nursing care concluding that nurses discriminate and that they do not treat the patients as dignified persons. Therefore nurses should be knowledgeable about the equal rights of the patients through their enhanced education to maintain equity and dignity while caring.

The participants of the study also had several expectations from the nursing staff during their labour and most of those expectations had been met by the participants. Most of the participants had overall satisfaction about the nursing care they had received as they recommended the same place (labour room) for the next time. As the participants were not satisfied with the communication and emotional support they received, it is important to develop communication skills by nurses in order to provide more effective care for the patients in the labour room to help them to cope with this emotionally and physically difficult situation.

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EFFECT OF PETHIDINE DURING LABOUR PROCESS: MOTHERS' PERSPECTIVE

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INTRODUCTION

Labour is one of the most painful conditions and is considered to be one of the most intense and stressful experiences which is a result of a complex and subjective interaction of multiple physiological and psychosocial factors (Cooper & Fraser, 2003; Maria, 2009). In the modern era various pharmacological and non-pharmacological methods are practiced for labour analgesia (Palmer, 2000; Kothari & Bindal, 2011). Pethidine is a widely used opioid drug for pain relief in labour (Gyton & Hall, 2000).

According to Sosa (2004) pethidine should not be used because of the absence of any benefits to patients with difficult labour. Furthermore, Ekblom, Ekman and Hjelm (2005) have revealed that labour pain is not sensitive to systematically administered morphine or pethidine and only cause heavy sedation. There are considerable doubts about the effectiveness of pethidine and concerns about its potential maternal, fetal and neonatal side-effects (Norris *et al*, 1994).

Many research studies reveal that pethidine has adverse effects on the mother as well as the baby. As a developing country, in Sri Lanka, there are not enough research studies done on the above. Therefore the purpose of this study is to study the effects of pethidine during the labour process from the mothers' perspective. The specific objectives are, to study the effect of pethidine on the mother related to pain, effect of pethidine on the mother related to side effects and effect on babies.

METHODOLOGY

The quantitative approach and descriptive design was used in this study. The population of this study was all postnatal mothers who have been given Pethidine to manage labour pain. Purposive sampling was used to choose the sample and the sample was 149 mothers in postnatal wards in the Teaching Hospital, Mahamodara. A self-administered questionnaire was used to collect the data. The questionnaire consisted of four main categories including demography, mothers experience related to pain, adverse effects related to pethidine and impact of pethidine on the baby. The reliability and validity of the questionnaire was confirmed by a pretest. Before administering the questionnaire ethical approval was obtained from the ethical committee of the Faculty of Medicine, Karapitiya. In addition, the researcher got informed consent from the participants. Statistical data analysis was done by using SPSS 16 statistical software.

RESULTS AND DISCUSSION

According to the findings, a majority of mothers (73.82%) reported that there was only a slight reduction of pain after administration of pethidine. Among that 42.27% of mothers had received pethidine in the latent phase and 31.55% had received it during the active phase. Only 4.02% of mothers reported that there was total reduction of pain while 20.8% of mothers reported no

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reduction of pain at all. Among mothers who reported that there was total reduction of pain, 2.68% had received pethidine during the latent phase and 1.34% had received in the active phase. These findings show that pethidine is more effective in pain management when it is given in latent phase (Table 1). On the other hand these findings show that there is no clear effect of Pethidine on pain reduction according to the mothers' perspective which is compatible with the majority of research findings (Pang & Sullivan, 2008; Ekblom, Ekman & Hjelm, 2005).

Table 1: Effect of Pethidine on mother related to pain

Response	Percentage of mothers %	
	Latent phase	Active phase
No reduction of pain	8.72	12.08
Slight reduction of pain	42.27	31.55
Total reduction of pain	2.68	1.34
Unresponsive	0.67	0.67

Latent phase: cervical os dilatation 1-3cm Active phase: cervical os dilatation 4-7cm

When considering adverse effects most of the mothers (52.34%) reported drowsiness while 16% reported dizziness and 8.72% reported nausea and vomiting. A considerable number of mothers (13.41%) experienced two or more side effects while only 9.36% of mothers experienced no adverse effects (Table 2). This evidence shows that a majority of mothers experience at least one adverse effect of pethidine whether they have received pethidine in latent or active phases as noted by Sosa (2004).

Table 2: Effect of pethidine on mother related to adverse effects

Side Effects	Percentage of mothers %	
	Latent phase	Active phase
Drowsiness	22.14	30.2
Nausea and vomiting	6.71	2.01
Dizziness	11.4	4.69
Two or more side effects	10.06	3.35
None	4.02	5.36

Table 3: Effect on babies to pethidine

Characteristics	Percentage of affected babies %		
	Total	Latent phase	Active phase
Not crying	1.3	34.2	65.8
Sucking difficulties	10.7	46.7	43.3
Difficulty in breathing	7.4	50	50
Administered Oxygen	6	44.4	55.6
Administered Naloxone	22.1	21.2	78.8

Pethidine influenced the baby in several ways like breathing difficulties and sucking difficulties (Maria, 2009). This study also has shown a considerable amount of babies (7.4%) with breathing difficulties. It may be due to pethidine. Apart from that, 10.7% of babies had sucking difficulties. Oxygen was given to 6 % of babies with severe breathing difficulties and 22.1% of babies were given Naloxone as an antidote for Naloxone. Percentages of the babies with problems from the mothers who have received pethidine at the active phase (cervical os dilatation 1-3 cm) were above 50 % for all the variables except sucking difficulty. So, there may be a association between the impact on the baby and the phase in which pethidine I given.

CONCLUSIONS/RECOMMENDATIONS

According to this study there is no significant impact of pethidine in terms of pain management while it has been proven to have adverse impacts on the mothers as well as the babies. Therefore the use of pethidine is questionable. Furthermore, it was evident that pethidine is more effective in pain management if it is given in latent phase. Apart from that, it was evident that there are considerable side effects that adversely affects the labour process. Further, the study suggested that if it is needed to give pethidine, it should be administered at the latent phase (cervical os dilatation 3-7 cm) of the labor process in order to minimize or reduce adverse effects on both mothers and the babies. However, all the above suggestions need to be revisited with future studies containing a larger sample representing mothers from all over the country.

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KNOWLEDGE AND ATTITUDES AMONG NURSES RELATED TO PROFESSIONAL NURSES' ASSOCIATIONS IN SRI LANKA

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INTRODUCTION

Nursing is a science dealing with the care of human beings and has a core mission to provide knowledge, apply evidence based care processes and advocate for change that improves individuals and society. A professional nursing organization will be formed by gathering the above intentions (Blias & Frock, 2004). These organized associations are extremely effective as they can influence policies which protect members of large organizations (Deleskey, 2003). The major responsibility of professional organizations is to establish and implement "Standards of Practice" (Wind, 2003).

In Sri Lanka, Nursing became institutionalized as a profession after a long period of time (Jayasekara & McCutcheon, 2006). The Sri Lanka Nurses' Association (SLNA) is the only professional association which has the membership of the International Council of Nurses' (Carey & Dier, 1995). The general purpose of establishing The Sri Lanka Nurses' Association was to contribute to the advancement of the nursing profession in Sri Lanka and to draw attention to the public towards this compassionate service. Thus, an examination of nurse related factors that affect the professional nursing organizations is very essential (De Silva & Rolls, 2010).

Most Sri Lankan nurses do not have professional attitudes towards nursing and consider their work merely as employment (De Silva & Rolls, 2010). In addition, access to professional nursing associations is also limited in Sri Lanka (Hiscock & Kadawathage, 1999). Therefore, it is necessary to have a speedy change in attitudes through a professional association.

The purpose of this study was to examine the knowledge and attitude among nurses' regarding professional nursing associations. The study was also carried out with the specific objectives of identifying nurses' existing knowledge and attitudes about professional nurses' associations in Sri Lanka, to compare knowledge and attitude scores between members and non-members of professional nurses' associations and to identify the barriers for nurses' involvement with professional nurses' associations.

METHODOLOGY

Quantitative descriptive design was used for this study. The study was conducted in medical and surgical wards of the Colombo South Teaching Hospital. Nurses' who had more than two years experience in the area of medical and surgical nursing were included in the study.

Simple random sampling method was used to select 100 registered nurses to examine the knowledge, attitudes and barriers that affected their involvement in professional organizational activities. A pretested validated self-administered questionnaire was distributed to collect data. The response rate was 82%. The questionnaire was designed to collect information on demographic data, details of knowledge related to professional nursing associations, attitude

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towards professional nursing associations, current involvement with such associations and barriers for involvement in professional nursing associations. Data collection was done during September, 2011.

Ethical approval was obtained from the ethical committee of the Colombo South Teaching Hospital before commencing the data collection. Informed consent was obtained from participants. The data analysis was done by using descriptive and inferential statistics. The results were statistically evaluated by using 't' test.

RESULTS AND DISCUSSION

Majority of the study group were between 25- 30 years of age. About 98% of the participants were females. (Table 1)

Table1: Distribution of the respondents according to socio-demographic characteristics

(N=82)

Characteristics	Number (N)	Percentage (%)
Age (years)		
25 – 30	44	53.6
30 – 35	17	20.7
35 – 40	11	13.4
40 – 45	04	4.8
45 – 50	04	5.1
50 – 55	02	2.4
Civil Status		
Married	41	50.0
Single	41	50.0
Sex		
Male	02	2.43
Female	80	97.56

Approximately 90% of respondents had heard about professional nursing associations. Majority (35.4%) of the study group were aware of the professional nursing associations from their nursing schools, while the lowest numbers were aware about such associations from internet sources (1.2%).

Both mean knowledge score (n=78, mean= 2.872) and mean attitude score (n=79, mean= 18.2) of the total study group has a statistically significant variation ($p < 0.0001$) than the expected maximum scores 5 and 30 respectively. That is the expected scores for the knowledge and attitude were not achieved by the study group. This finding has previously been proven by the ethnographic study by De Silva and Rolls (2010).

There is no statistically significant variation in knowledge and attitudes scores between the members and non- members of professional nursing associations. (Table 2 and Table 3)

Table 2: Comparison of knowledge score on nursing professional associations among members and non-members

Membership status	Number of participants	Knowledge score		'P' value
		Mean	SD	
Members	16	3.031	1.147	0.4066
Non members	65	2.777	1.079	

Table 3: Comparison of attitude score on nursing professional associations among members and non-members

Membership status	Number of participants	Attitude score		'P' value
		Mean	SD	
Members	14	19.86	8.529	0.3433
Non members	66	18.05	5.957	

Approximately 57% of the study group had membership on a trade union. While only 19% of the study group had membership in professional nurse's associations. About 11% of the participants had membership in both associations. Seventy five percent (75%) of members of the professional nurses associations had membership for more than 02 years. However, only 43.75% of members of professional nurses associations had participated in more than 02 annual meetings for the last three years. This result shows a similarity to the result shown by Blais and Frock (1987).

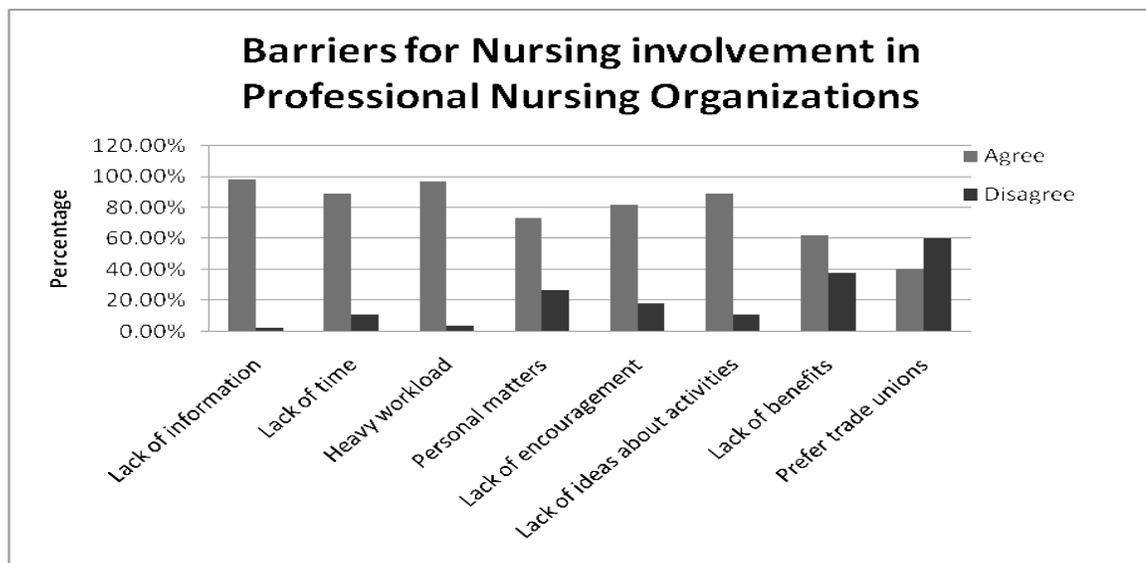


Figure 1: Barriers for Nursing involvement in Professional Nursing Organization

A majority of the study group considered lack of information, lack of time, heavy workload, personal matters, lack of encouragement and lack of benefits as the barriers for involvement in professional nursing associations. (Figure 1) A study by White and Olson (2004) indicated that the barriers for non-participation in professional associations were very similar to the present study. They had found family responsibilities, lack of information, and lack of time as the major barriers.

CONCLUSIONS/RECOMMENDATIONS

Although the Sri Lanka Nurses Association celebrates its 70th anniversary, nurses' knowledge, and attitudes regarding professional nursing associations is not at a satisfactory level. The level of knowledge and attitudes regarding professional nursing associations were not related to membership status. Barriers for nursing involvement with professional nurses' associations includes lack of information, lack of time, heavy workload, personal matters, lack of encouragement and lack of benefits.

The study recommends that the Sri Lanka Nurses' Association should implement programs to integrate the international trends related to professional nursing associations. Furthermore, this study should be extended to other major hospitals to get a clear picture about nurses' involvement with professional nursing associations.

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BODY IMAGE PERCEPTION AND DIETARY PATTERNS AMONG TEENAGE GIRLS

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INTRODUCTION

A close relationship exists between nutrition and human health (Wickramanayake, 1996). To maintain a healthy lifestyle, having a balanced diet is very important. To achieve a balanced diet humans are supposed to adhere to the recommended dietary intake declared by the World Health Organization. This recommended dietary intake varies according to the developmental stages of human life. Among the different developmental stages of human life, the growth spurt is specifically attributed to teenagers. Growth spurt is defined as the period during which a rapid increase in height, weight, and muscle mass are taking place. During this particular period, teenagers try to create their own food habits without the guidance of parents (Kaslow, 1998). Ignoring their recommended diet for this specific age more teenagers in general, refuse their regular diet and create their own food habits aiming to have their desired body image. In particular, teenage girls are the most vulnerable group who engage in this malpractice because of their concern about the socially prescribed body image of having a thin body shape. Body image is defined as a subjective picture of one's own physical appearance by self observation and by the reaction of others (Oxford, 2005). Especially, teenage girls perceive their body image based on values shared by peer groups (Pruneti. *et al*, 2007) Moreover, some studies found that every teenager imitates the body shape and image of socially appreciated persons such as artists, singers or popular persons (Khor, 2009). This results in pushing them to achieve a so called popular body images using uninformed dietary practices and unhealthy habits which affects desired growth. These malpractices of food habits among teenagers lead to deteriorated health among them. This situation creates major health problems such as malnutrition and anemia among the teenage population (Medical Research Institute, 2010). This has become a major social issue and this may lead to further problems in the future generations such as low birth weight babies (Marlow, 1998). Therefore, it is a timely to explore the dietary habits and body image perception among teenage girls.

METHODOLOGY

This study was carried out using a quantitative approach in the area of the Medical Officer of Health (MOH), Weerambagedara. Quantitative research refers to data to be collected in numerical form and especially focuses on natural setting (Diachuk, 1995). In this study a descriptive design was used to capture the teenage girls' dietary practices and body image perception as human characteristics. Further, the study mainly focused on exploring the existing current situation of the issue.

Sample size was 400, 16-19 years aged teenage girls selected from MOH area Weerambagedara using the purposive sampling technique. Questionnaire was used as the tool for data collection and data were analyzed using descriptive statistics.

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Considering the strengths of this design, it is easy to implement the descriptive design according to the purpose of this study because manipulation, control, and randomization are not required to describe a natural situation (Burns, 2009).

RESULTS AND DISCUSSION

Out of the 400 participants, 270 (67.5%) were used to an unhealthy dietary pattern. Healthy dietary pattern was used by 130 (32.5%) participants of them. Therefore, these results clearly showed (Figure1) that teenage girls were more prone to have unhealthy dietary practices.

Taking the data into further consideration the knowledge of participants is poor regarding a balanced diet.

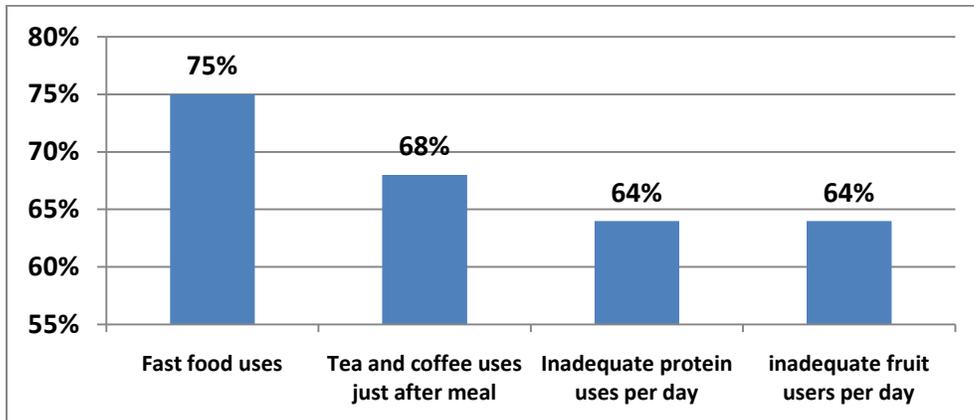


Figure 1: Practices of Unhealthy dietary habits

In terms of participants' attitudes and beliefs of their own body image, relating to their dietary practices and Body Mass Index (BMI), the study could find the following differences among them.

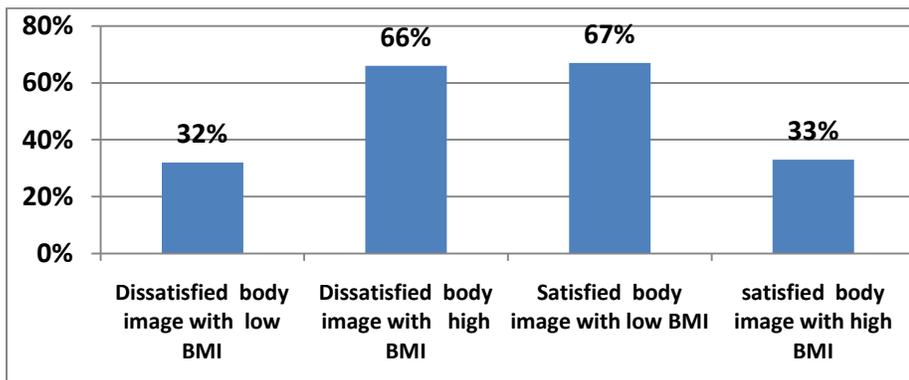


Figure 2: Relationship of Attitude & beliefs on body image and BMI

These results showed that most of the participants are dissatisfied because of their high BMI as well as low BMI rates while surprisingly few were satisfied for the same reasons.

Participants were dissatisfied with their own body image (Figure 2) due to different influencing factors, such as mass media (70%), parental influence (8%), attractive dress for slim body (11%) and peer group influence (22%). According to the findings relatively higher numbers of participants were influenced by mass media.

The study further identified some perceived barriers among teenage girls in achieving desired dietary practices in relation to maintaining their desired body image (Figure 3).

The findings of the study showed that a majority of the participants had a normal BMI. However, a considerable number of underweight teenagers presented in the age group of 17 – 18 years (Fonseka & Waliange, 2006). In contrast, O’Dea (2010) found higher prevalence of overweight and obese teenagers among Australian adolescents. This may be due to the influence of genetic factors inherent to western people and food patterns in their culture.

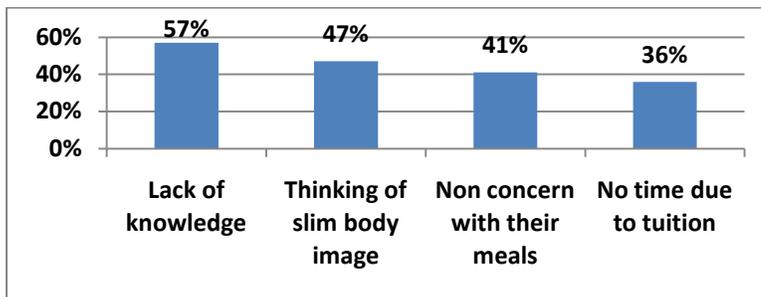


Figure 3: Barriers to maintain desired dietary practices

A majority of the participants were used to having unhealthy dietary patterns. Healthy dietary patterns were used by very few of them. As a whole Sri Lankan society normally has three meals and two snacks per day. A majority of the participants in the study were also the same. But their meals were not rich in nutritious elements. They consumed more vegetables and low amounts of fat, protein and fruit. This is similar to the study finding of Sukumaki (2005). This dietary pattern may lead to developing anemia and vitamin deficiency. Furthermore, the nutrition and food survey, Ministry of Health (2010) indicated that the above nutritional deficiencies are evidenced among school children.

Even while having normal BMI, many teenagers were dissatisfied and perceived themselves as being in the overweight category. Also some underweight participants perceived themselves as being overweight. Both groups believed in dieting as a strategy to lose weight. The smallest proportion of the sample were teenage girls who were dissatisfied due to thinness. This finding is nearly similar to another study (Khor *et al*, 2009). This is in contrast to the study of O’Dea(2010). Furthermore, out of the whole sample a significant number of participants had engaged in dietary control in the past. Some of them still used particular diet menus. Both groups had not followed advice from a dietitian. Considering the knowledge about nutrition of teenage girls, a majority had less knowledge about their nutrition needs. At the very least they were not aware about the food groups, which are necessary to be included in their diet. This finding is nearly similar to a few other studies in other countries (Khor *et al*, 2009). Fonseka and Weliange (2006), the Sri Lankan researchers also identified the need for improving knowledge of adolescents regarding their nutrition.

Considering the perception of the body image, the majority of teenage girls were concerned with their body shape. This finding is similar to other studies (Khor *et al*, 2009), which have also found teenage girls to be concerned and preoccupied with their body image (Sukamaki *et al*, 2005). In this study, a considerable percentage of participants were dissatisfied with their body image. Adkins and Stivers (2008) explored similar findings. According to the findings of the present study more than half of the participants who were dissatisfied with body shape were dissatisfied due to the influence of the media. The rest of the participants were influenced by family members and peer group in relation to their dissatisfaction. Considering the above finding,

it is clear that the most powerful factors in shaping attitude of teenage girls and for creating negative self-esteem about their body image are family and media. Further peers play an integral role in shaping attitude among teenagers concerning body image and weight loss behavior (Burns, 2009).

While exploring the barriers among teenage girls, the researchers identified a lack of knowledge as the major barrier to maintain desired, proper dietary practices in relation to maintain their desired body image. Other barriers are, non-concern about meals and lack of time to take meals due to tuition. O'Dea (2010) identified barriers as insufficient physical education, and physical activity to maintain desired body image.

Consideration of body image is common among adolescents, as they undergo rapid physical growth and body shapes changes. Dietary habits and body image perception is an interrelated concept in different groups (Carlo, 2000). Teenagers especially are more concerned about body image. Therefore, they tend to practice distorted dietary habits. This situation may lead to numerous bad effects in their future lives.

CONCLUSIONS/RECOMMENDATIONS

Having a distorted body image may lead to negative effects such as unhealthy eating habits and disordered eating behaviors. It is recommended that appropriate educational efforts on body image and nutrition be implemented in to school health activities for teenage girls.

It is important to recommend educational programmes for the girls and their parents regarding nutrition of the adolescents. Further research is recommended regarding adolescents' nutrition using different approaches. Appointing a community health nurse is highly recommended.

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FACTORS INFLUENCING GASTRITIS: A PRELIMINARY STUDY FOR ASSESSMENT OF KNOWLEDGE, ATTITUDES AND PRACTICES AMONG PATIENTS WITH GASTRITIS

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INTRODUCTION

Gastritis is inflammation of the gastric mucosa and it is diagnosed and classified histologically because endoscopic appearances such as redness are often misleading (Bebba *et al.*, 2003). The researchers further highlighted that the most important causes of gastritis were *Helicobacter pylori* infection, nonsteroidal anti-inflammatory drugs (NSAIDs) and autoimmunity. Life style changes, drugs, stress and life habits can also be causative factors for gastritis (Heitkemper, 2000). The risk factors for gastritis that have been identified in Sri Lanka are frequent use of analgesics, anti-rheumatics and antibiotics, missing or delaying meals, consumption of spicy or starchy food, less physical activity and alcohol consumption (Waidyarathna *et al.*, 2008).

As there have been very few studies done on factors affecting gastritis in Sri Lanka it is important to identify the common factors influencing gastritis. The main purpose of this study was to examine the factors influencing gastritis, among patients with gastritis attending the gastrointestinal clinic (GI clinic) in the National Hospital of Sri Lanka (NHSL). The study was carried out with the specific objectives of assessing knowledge, attitudes and practices and to identify the barriers related to controlling gastritis among patients with gastritis. It is important to develop good health practices and to overcome existing barriers to minimize gastritis. Hence the findings of this study can be used to take necessary measurements to increase the awareness about gastritis and to minimize the occurrence of this disease.

METHODOLOGY

A quantitative descriptive study was conducted at the GI clinic, NHSL. Patients who were diagnosed with gastritis were included in the study group. Data were collected within the month of January 2013. Purposive sampling method was used to recruit 200 participants. A self-administered questionnaire was used as the data collection tool and it was given after obtaining informed written consent. The response rate was 90.5% (N=181). The questions were directed towards gaining information on patients' demographic data, knowledge and attitudes, existing causes for gastritis and barriers related to controlling gastritis. Data were analyzed using Microsoft Excel. Ethical approval was granted by the Ethical Review Committee of NHSL.

RESULTS AND DISCUSSION

Demographic characteristics, knowledge and attitudes regarding gastritis

There were 65% females and 35% males out of the total number of participants. Fifty percent of the study group was between 30-50 years of age. The education level of most of the participants was up to Advanced Level (46%). Participants from urban areas (40%) and suburban areas (41%) were higher than the number of participants from rural area (19%).

According to the findings, the knowledge level of participants was identified as excellent, good, poor and were respectively 79%, 13.3% and 7.7%. Gastritis and its development were understood by 82% of participants. The most common symptom was identified as abdominal pain by 81% of

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the participants. Sixty six percent of participants identified endoscopic examination as the most helpful investigation for gastritis. The level of attitudes on gastritis was identified as poor (66%). The majority (66.3%) agreed that gastritis can be treated with medications. Out of all participants 55.8% was aware about their disease. According to the findings the levels of knowledge and attitudes on gastritis were contradictory and the same results were shown by Bystrove (1985).

Table 1: Demographic characteristics regarding gastritis patients at GI clinic (N=181)

Demographic factors	Number (N)	Percentage (%)
Age		
Below 30 years	32	16
30-50 years	90	50
Over 50 years	59	34
Gender		
Male	64	35
Female	117	65
Level of Education		
Not attended school	6	4
Up to grade 5	11	6
Up to G.C.E. Ordinary Level	67	37
Up to G.C.E. Advanced Level	85	46
Graduate	12	7
Higher level	0	0
Living area		
Urban	73	40
Suburban	74	41
Rural	34	19

Table 2: Practices and most contributing factors to gastritis (N=181)

Practices and contributing factors to gastritis	Number (N)	Percentage (%)
Stress		
Having stress recently	165	91

No stress recently	16	9
Stressed for personal matters	80	84
Stressed for other matters	15	16
Food Pattern		
Skip meals	17	18
Taking high chilly & spicy food	57	31
Not having regular pattern	73	37
Diseases		
Heart disease	49	27
Asthma	41	22
Arthritis	22	12
Life habits		
Smoking	20	11
Alcohol taking	6	3

Practices and contributing factors to gastritis

The majority of participants (91%) reported “having stress recently” as the main existing cause for gastritis. Among them 84% of participants had stress due to personal reasons (Table 2). Meals were taken irregularly by 37% and skipping meals were noted by 18%. Thirty one percent of participants favored high chilly and spicy food. Refined food was favored by 31% of the participants. Seventy one percent of participants were not consuming alcohol. This finding might be due to the lesser number of male participants included in the study sample. Among the study group 27% had gastritis after taking drugs for heart disease and 22% had gastritis due to drugs taken for asthma. This suggests that gastritis can evolve as a side effect of medications taken for some other disease conditions.

The study found some barriers related to the management of gastritis such as lack of adequate Gastro Intestinal Clinic facilities or endoscopy facilities in rural areas, difficulty in affording medications and unwillingness to have medications continuously for six months. (Figure 1)

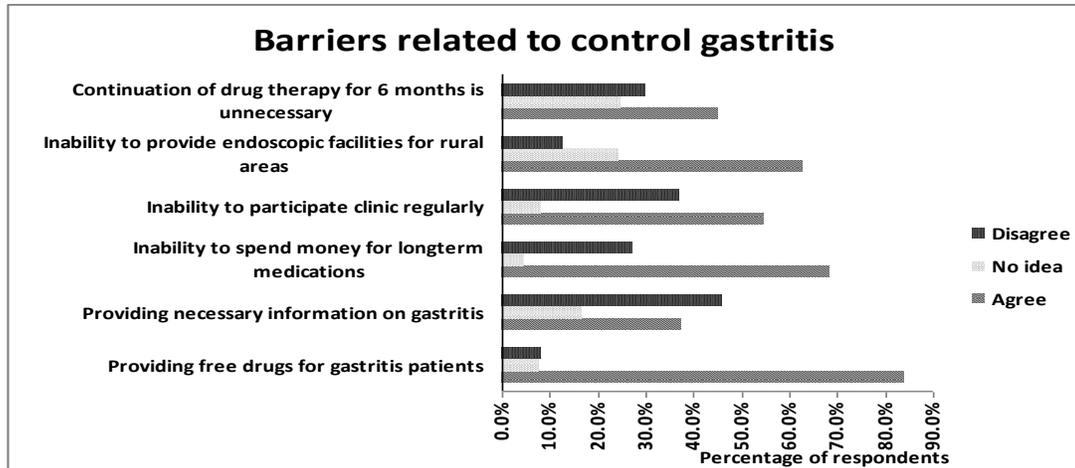


Figure 1: Barriers related to control gastritis.

CONCLUSIONS/ RECOMMENDATIONS

According to the findings of this study, stress, food pattern, taking long term medications for heart disease, asthma and arthritis and some life habits were identified as influencing factors for gastritis. Among the existing factors for gastritis the most common factor was stress. The overall knowledge of the participants on gastritis was excellent but the attitudes were poor. Barriers related to controlling gastritis were identified as lack of Gastro Intestinal Clinic facilities or endoscopy facilities in rural areas, difficulty in affording medications and unwillingness to have medications continuously for six months.

As most of the respondents were females, it was difficult to find the effects of smoking and alcohol intake on gastritis. The generalizability of the findings can be affected since this study was conducted only at the GI clinic, NHSL.

Finally this study recommends upgrading public attitudes about factors influencing gastritis through posters, leaflets and providing necessary information for patients attending the GI clinic. Endoscopy facilities should be made available in rural areas by the government. Further studies are recommended to identify the existing situation in other areas to have an overall picture about gastritis.

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AN EXPLORATION OF DIETARY MANAGEMENT PRACTICES OF DIABETES MELLITUS PATIENTS

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INTRODUCTION

Today, major threat to health is non communicable diseases. Diabetes Mellitus has become one of the most common non communicable diseases. It is a group of metabolic diseases with multiple etiologies, characterized by hyperglycemia together with disturbances of carbohydrates, fat, and protein metabolism resulting from defects in insulin secretion, insulin action or both (Frank 2003). Despite the age, people all over the world are suffering from the Diabetes Mellitus. Individuals are expected to incorporate major changes in diet which is the cornerstone of treatment. However, this is the most difficult component of self management. Out of the self management activities of diet and exercises, the priority should be given to dietary management.

Diabetes Mellitus has potential for serious complications and often results in significant financial burden, decreased quality of life and major lifestyle changes for patients and their families (Coffey et al. 2002). Most individual are likely to come across barriers to care which create major challenges in adhering to self management programmes (Aljasem et al. 2001, Clark & Hampson 2001, Schoenberg & Drungle 2001). In addition, research shows that those with multiple barriers are less attached to their plans of care (Glasgow 1994). The most frequently reported barriers are time constraints, knowledge deficit, limited social support, inadequate resources, limited coping skills, poor patient – provider relationship and low self -efficacy (Tu & Morrison 1996, Whitmore et al. 2002). Thus, extent of dietary management of these diabetic patients should be thoroughly examined and encouraged.

Diabetes Mellitus is a real burden to the patient and the family. Further, there is an increasing trend of recurrent hospital admissions of diabetic patients due to uncontrolled blood glucose level and associated complications. This is a large cost for the government. At the same time, it decreases the number of healthy population and affects on the development of the country. So, prevention and control of the disease is essential. Even though, diet control is more effective in controlling the blood sugar level, most of these patients are less prone to use this practice. Therefore, this study explores the extent of dietary management used by the type two diabetic patients in urban and sub urban settings.

METHODOLOGY

Quantitative descriptive design has been employed in this study to assess the dietary management of diabetic patients. The study was conducted in natural settings of diabetic clinics, at North Colombo Teaching Hospital at Ragama and Siyasi Private Hospital at Kuliyaipitiya with a purposive sample of 150 diabetic patients (50 diabetic patients from North Colombo Teaching Hospital and 100 diabetic patients from Siyasi Private Hospital). Diabetic patients who had other diseases, such as Hypertension, Heart diseases has been excluded from the sample and those without any other diseases and with fair knowledge of reading and writing in Sinhala has been

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included. Voluntary participation was invited and informed consent was obtained. Ethical approval and permission to gain access was sorted from both hospitals.

Data collection was conducted by the research team using a self administered questionnaire which was prepared in English and translated in to Sinhala. The Sinhala version was back translated to check the accuracy. The questionnaire was pre tested for reliability and understandability with a small sample of ten patients who did not participate in the study. Edited version was distributed. Data collection was done within a period of 25 days. Descriptive analysis was conducted using Microsoft excel package.

Lack of experience of researchers and time constraints were identified as limitations. In addition, the quantitative nature of the data collection tool and closed ended questions has limited the collection of in depth data and expressions of individual experiences on dietary management. Patients' personal factors such as anxiety, fatigue, tiredness and hunger might have an impact on the responses and most probably the answers could be superficial. A busy clinic environment could also have an impact on the findings.

RESULTS AND DISCUSSION

Out of the 150 questionnaires, 145 were returned. Thus, the response rate was 97%. According to the demographic data, 60% of the sample was from urban areas and 40% were from rural areas. Regarding the age of participants, 27.5 % was below 40 years, 37.9% were between 41 to 50 years and the rest, 34.5% were over 51 years. In relation to employment, 40.6% of the

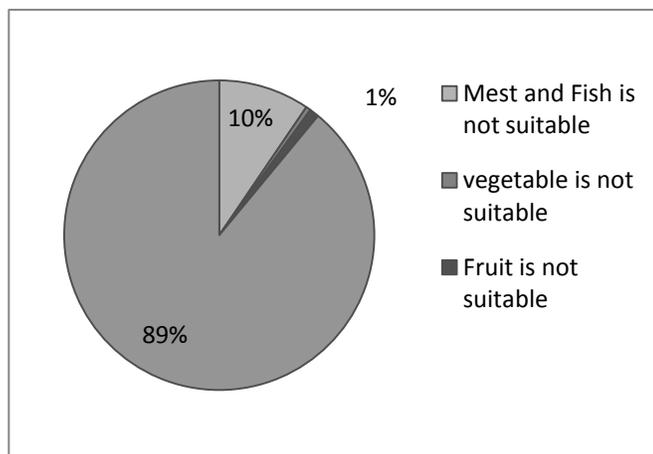


Figure 11: Knowledge on food consumption

participants was private institutional employees, 24.8% were government employees, 6.8% were self employees and 27.6% were unemployed. Monthly income of 71% of the sample was higher than 25,000 rupees. Another 14% had 20,000 to 25,000 rupees and the rest, 16% had a monthly income below 20,000 rupees. Only 40% of the sample had completed GCE Advanced Level thus the educational level was fairly good.

Although this group should concern about their weight, 65.3% of the sample were above 66 kg. and 63.3%

did not attend to health education classes during their clinic visits. Rosenstock et al. (2008) identified the effect of lifestyle modification on body weight and glucose tolerance. The figure 1 below illustrated that 89% of the sample had sufficient knowledge about consuming carbohydrates in their meals. But, only 7% (10) of participants correctly defined what a diabetic diet is. Data also revealed that 72.4% of the sample had a habit of taking fast food. Rice consumption was varied among the sample and 45% had two cups per meal. Another 48% had three cups per meal which is more than the recommended quantity. Consumption of sweets was high with 19% of the sample. These findings are consistent with other studies that reported, despite the diet is the most challenging aspect of diabetic care, 48% to 75% of respondents do not correctly adhere to dietary recommendations (Glasgow et al., 1984, Whitmore et al. 2002, Anderson & Justafson 1998, Lipscomb et al., 2002). The study revealed that fruit consumption of diabetic patients is at moderate level. But, this level should be higher than current consumption,

because fruits contain high fibers and it increases the filling effect of the stomach. This helps to reduce the carbohydrate consumption of diabetic patients.

Patients were worried about the loss of their usual lifestyles and many struggled with reframing their eating habits to promote a healthy body and lifestyle. Changing eating habits is often difficult because it requires routine mealtimes, changes in the amount and types of food, loss of spontaneity in eating, and changes in relational behaviors. As 30% had an income less than 20,000 rupees this is an additional burden and reported high cost of buying healthy foods in order to maintain recommended diet. Anderson et al. (2001) and Rubin et al. (2004) identified that helplessness, frustration and the lack of success in achieving optimal glycaemic level, leads to ineffective coping methods such as denial or indifference.

However, 93% of the sample knew that diet control helps to maintain blood sugar level. Among the participants, 92.4% (134) knew faintishness as a symptom of hypoglycemia. Fasting blood sugar investigation was used by 70% of the sample as their method of identifying blood sugar control. Data revealed that the current group education structure and the delivery method do not have the ability to meet the needs of people with diabetes because patients expect more specific

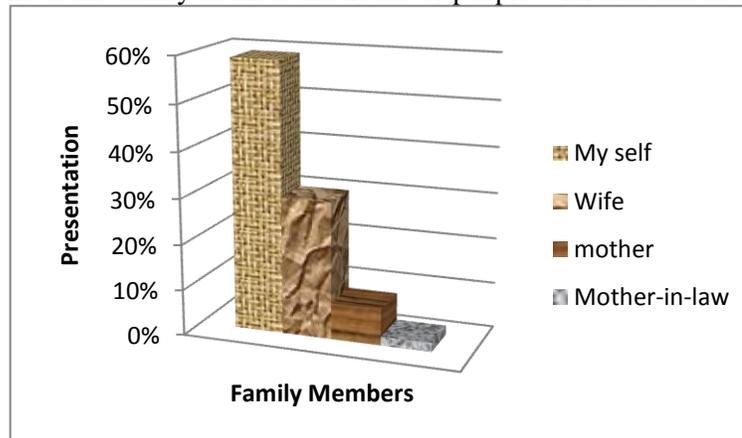


Figure 12: Meal Preparation

information about their disease and management. Brown *et al.*, (2002) identified that patients' motivation and willingness to assume responsibility for their own care is the key to effective self-management.

Further, this study examined the responsible people who prepared these patients meals. Though the patient gets the knowledge, the person who prepares meals might not have adequate knowledge. Out of them 59% prepared their own

meal so, they knew. The remaining 41% had their meal prepared by their spouses, mothers or in-laws in the house. If there are many family members at home, the priority was given to the needs of other members in the family (children, male persons, elderly pregnant mothers) when preparing meals. Although diabetic patients should have highly nutritious, low carbohydrate and high fiber diets, may not get as recommended.

CONCLUSION AND RECOMMENDATIONS

Diabetic patients strive for normality while situations demand daily assessment of biophysical needs, implementation of appropriate management strategies and evaluation of treatment effectiveness. How they react to their disease process differs from person to person. This depends on their psychological state, the barriers they encounter in their social situations, internal and external environment they live in. Without knowing the rationale or importance of strategies, patients often fail to implement them.

Data of this study indicated that the education structure and delivery applied for the current group may not meet the needs of people with diabetes. The information which was provided has been perceived as not adequate. Patients wanted diabetic education with specific information relevant

to their disease. Health care providers should experiment with interactive educational strategies that lead to successful integration of changes into their lifestyle.

The findings also revealed that most of the diabetic patients had poor overall knowledge, practice and attitudes about diet control. As a result, a large percentage of patients did not use dietary management leading to overweight problem associated with diabetic mellitus. Current study results revealed that female patients played a dominant role in preparing meals. If the patient is male person, the meal preparation is done by the wife. As the meal preparation has given the priority to other family members, diabetes patients may not get their food as recommended. Therefore the family support is very important.

In healthcare settings, the nurse has the key responsibility to educate the clients. The identified gaps such as poor knowledge, poor attitudes and weak practices about the diet control, need to be addressed in health education sessions using interactive educational strategies. Anticipatory discussion of potential feeling of frustration with self-management such as dietary management may help patients to avoid clinical depression. In addition, healthcare workers can facilitate acquisition of essential supplies and educational resources for patients and their families by facilitating the use of community resources. All these aspects may enhance the empowerment and increased control in self management of diabetes in these patients. Further, it is recommended to conduct this research using qualitative approach to explore the insider's perspective of self management of diabetes.

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KNOWLEDGE AND PRACTICE REGARDING PHYSICAL ACTIVITIES DURING PREGNANCY AMONG PREGNANT MOTHERS ATTENDING ANTENATAL CLINICS IN THE COLOMBO SOUTH TEACHING HOSPITAL

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INTRODUCTION

The study aimed to:

Assess knowledge regarding physical activities done by pregnant women throughout their pregnancy period.

Identify types of physical activities practiced by pregnant women throughout their pregnancy period.

Identify factors affecting knowledge and practice of a pregnant mother.

Pregnancy is a physiological condition. However, there are a number of physiological and psychological changes that occur in pregnancy (Teixeira, *et al.*, 2005). These physical changes lead to minor & major physical problems at several stages in the pregnancy period.

Research conducted globally shows that most maternal morbidities and mortalities can be minimized by physical activities during pregnancy. A study shows that pregnant women are less active than non pregnant women and pregnancy leads to a decrease in physical activities (Evenson, *et al.*, 2002). But pregnant women should have a proper knowledge regarding physical activities to be put into practice (Hegarad and Gross, 2000). Such engagements help to increase the stretching ability of their pelvic muscles that facilitates the labour process. This prevents unnecessary tears, haematomas, infections, reduces mental tension and prolonged hospitalization of both the mother and the baby (Brown, 1986). Brisk walking, regular breathing exercises and climbing steps (mild to moderate physical activities) are advisable to be practiced during pregnancy. Cycling, running, swimming and heavy lifting (strenuous physical activities) should be prevented (Juhl, *et al.*, 2005).

METHODOLOGY

A descriptive cross sectional study was conducted using 210 pregnant mothers registered at Antenatal Clinics in the Colombo South Teaching Hospital. They were in various gestational periods, various educational levels, different parities & age spectrums. A systematic random sampling was done to pick pregnant mothers from the population. An interviewer administered questionnaire was used to collect data from the sample. Pregnant mothers who were unable to communicate either in English or Sinhalese were excluded. Data analyzing was done by using SPSS 16 version. Data collection proceeded after getting the ethical clearance from the Ethical Review Committee of Faculty of Medical Sciences and Colombo South Teaching Hospital.

RESULTS AND DISCUSSION

More than half of the study sample (55%) consisted of the age group of 25-31. 91% of pregnant mothers in the study sample had completed their secondary education (Table 1). Three quarters of the study sample were house wives. 63% of the study sample was in their third trimester. More than three quarters of mothers didn't have any morbidity conditions in their present gestation. More than half of the mothers (57%) were primi mothers.

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Table 1. Distribution of knowledge of the study sample by their highest educational level. (n= 210)

Characteristics	Highest Educational Level of the Subject			Total (N) (%)
	Primary Education (N) (%)	Secondary Education (N) (%)	Tertiary Education (N) (%)	
Good Knowledge (N)	0 0.0%	23 12.0%	3 37.5%	26 12.4%
Moderate Knowledge (N)	4 36.4%	107 56.0%	4 50.0%	115 54.8%
Poor Knowledge (N)	7 63.6%	61 31.9%	1 12.5%	69 32.9%
Total (N)	11 100.0%	191 100.0%	8 100.0%	210 100.0%

$\chi^2 = 10.455$, $df = 4$, $p < 0.033$

88% of pregnant mothers who had a tertiary education had good to moderate knowledge. Of the pregnant mothers who had secondary education only 68% had good to moderate knowledge. $\chi^2 = 10.455$, $df = 4$, $p < 0.033$. This indicates that the educational level of a pregnant mother influences knowledge of physical activities. The educational level of the husband also influence 88% the knowledge of physical activity during the pregnancy period ($\chi^2 = 10.656$, $df = 4$, $p < 0.031$). However, age, profession, gestational period, parity and risk factors to pregnancy did not affect the knowledge regarding physical activities during pregnancy.

95% of pregnant mothers engaged in walking before and after pregnancy, while 5% who walked before pregnancy didn't walk after they became pregnant, $\chi^2 = 29.652$, $df = 1$, $p < 0.000$ (Table 2). This statistical significant indicates that brisk walking is the common physical activity done by pregnant women in every gestation stage. 95% of pregnant mothers engaged in doing house hold activities before pregnancy and 5% mothers who did house hold activities before, stopped these activities after becoming pregnant ($\chi^2 = 62.746$, $df = 1$, $p < 0.000$). This indicates that pregnant women continue doing physical activities after becoming pregnant. 70% of pregnant mothers did breathing exercises before & after they became pregnant while 30% who did breathing exercises before pregnancy stopped doing it after they became pregnant ($\chi^2 = 66.815$, $df = 1$, $p < 0.000$). This practice by pregnant mothers indicates that they have realized the benefits of doing deep breathing exercises. Swimming after pregnancy is discontinued by mothers who have done it earlier ($\chi^2 = 9.610$, $df = 1$, $p < 0.02$). The statistical significant between prolong standing before and after pregnancy shows that they are keen over the disadvantages of it ($\chi^2 = 29.470$, $df = 1$, $p < 0.000$). Women who drive before pregnancy stopped it after becoming pregnant ($\chi^2 = 58.314$, $df = 1$, $p < 0.000$). 79% who did heavy lifting before pregnancy stopped it after they became pregnant. $\chi^2 = 31.380$, $df = 1$, $p < 0.000$. This is statistically significant. Whereas cycling, running, & dancing don't show any significance before or after pregnancy period.

85% of pregnant mothers scored highly in their interview (Table 3). All of them continued practicing physical activities even after pregnancy ($\chi^2 = 7.599$, $df = 2$, $p < 0.022$). This indicates knowledge regarding physical activities motivates them to practice it even after becoming pregnant.

Table 2. Distribution of walking in the study sample after they became pregnant by before pregnancy. (n=210)

Characteristics		Before Pregnancy-		Total (N) (%)
		Walking Yes (N) (%)	No (N) (%)	
After Walking	Pregnancy- Yes (N)	193 95.1%	3 42.9%	196 93.3%
	No (N)	10 4.9%	4 57.1%	14 6.7%
Total (N)		203 100.0%	7 100.0%	210 100.0%

$\chi^2 = 29.652$, $df = 1$, $p < 0.000$

Table 3. Distribution of continuing physical activities in study group by knowledge. (n=210)

Characteristics	Total Marks Scored for the Questionnaire			Total (N) (%)	
	Good Knowledge (N) (%)	Moderate Knowledge (N) (%)	Poor Knowledge (N) (%)		
Continue Physical activities	Yes (N)	22 84.6%	77 67.0%	38 55.1%	137 65.2%
	No (N)	4 15.4%	38 33.0%	31 44.9%	73 34.8%
Total (N)		26 100.0%	115 100.0%	69 100.0%	210 100.0%

$\chi^2 = 7.599$, $df = 2$, $p < 0.022$

CONCLUSIONS AND RECOMMENDATIONS

Teenagers, married couples and pregnant women should be educated on advantages and disadvantages of doing physical activities throughout the pregnancy period. Education regarding physical activities should be given to the couple to get better results.

Both (husband & wife) should be motivated to have brisk walks together. Couples should be motivated to do their house hold activities together.

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EFFECTS ON TRAFFIC FLOW DUE TO THREE-WHEELERS PARKING NEAR ROAD INTERSECTIONS

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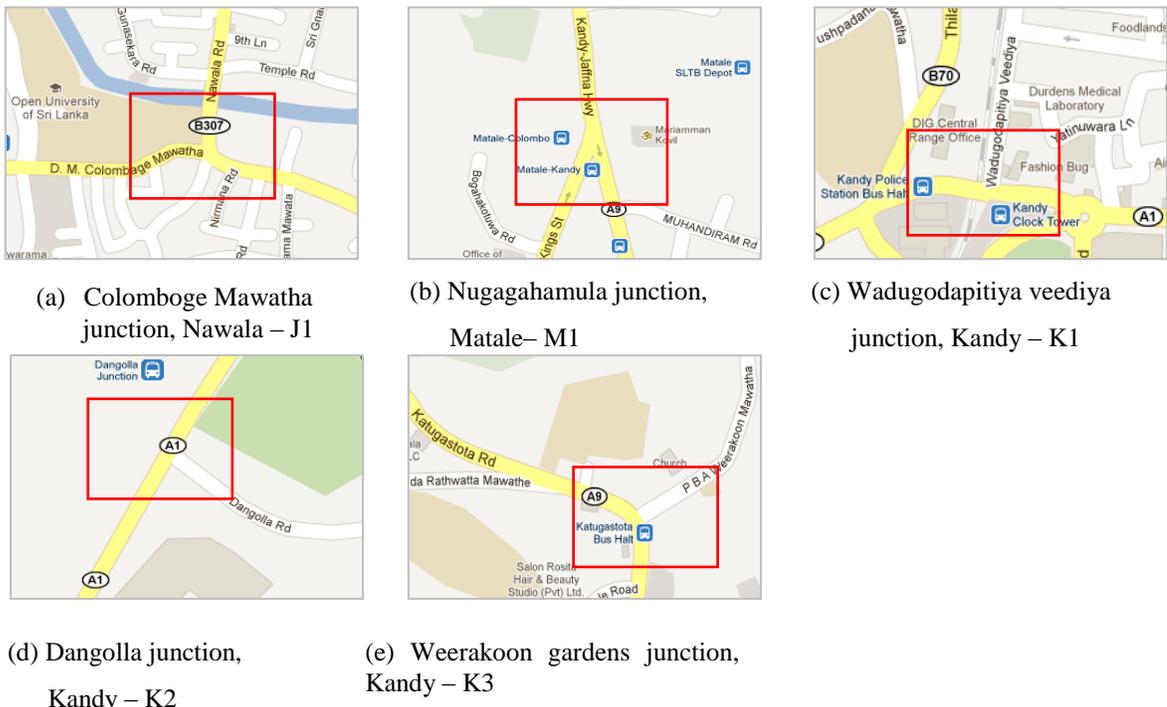
INTRODUCTION

Three-wheelers have rapidly become a popular mode of transport in Sri Lanka during last three decades. This mode of transport became popular due to its free availability, less road space occupation, low travel and maintenance cost. Due to these reasons and its comparatively low purchase cost, people are tempted to purchase or hire three-wheelers for their day to day travel. The annual growth rate of three-wheelers is 15.4% as per Department of Motor Traffic statistics.

Three-wheelers are mostly used for hiring purposes as an alternative for taxis. Three-wheeler operators obtain assigned parking areas from the municipal council or urban councils. It could be seen that municipal councils and urban councils are in the habit of permitting three-wheelers to park near road intersections of congested city/town roads. This leads to visibility obstruction at intersections, reduce road capacities, and bottle-necks the approaches of the intersection, causing inconvenience to both pedestrians and drivers, affecting the smooth flow of traffic. Through-put of the intersection may also reduce causing accidents at these locations (Weerasekera, 2009).

Through this study it is expected to investigate any negative effects on average delays and exit rates to minor road vehicles, accident effects etc. due to the three-wheeler parks near road intersections. Five road intersections from *Kotte*, *Kandy* and *Matale* municipal areas were selected for the study (Figure 1). These study locations were selected in such a way that they had no external effects other than the direct effect due to the presence of three-wheeler parks near road intersections.

Figure1-Selected study locations



METHODOLOGY

- Collected information from the municipalities, urban councils any other permit issuing institutions about any rules, regulations or guidelines for permitting three-wheeler parks.
- Collected accident data from *Mirihana, Kandy* and *Matale* police stations before and after implementing three-wheeler parks near road intersections.
- Conducted traffic surveys and studied traffic flow patterns to observe exit rates and average delays at intersections.
- Analysed results and quantified the effects on exit rate and average delay.
- Conclusion and proposed recommendations for effective three-wheeler parks.

Data collected from municipal councils

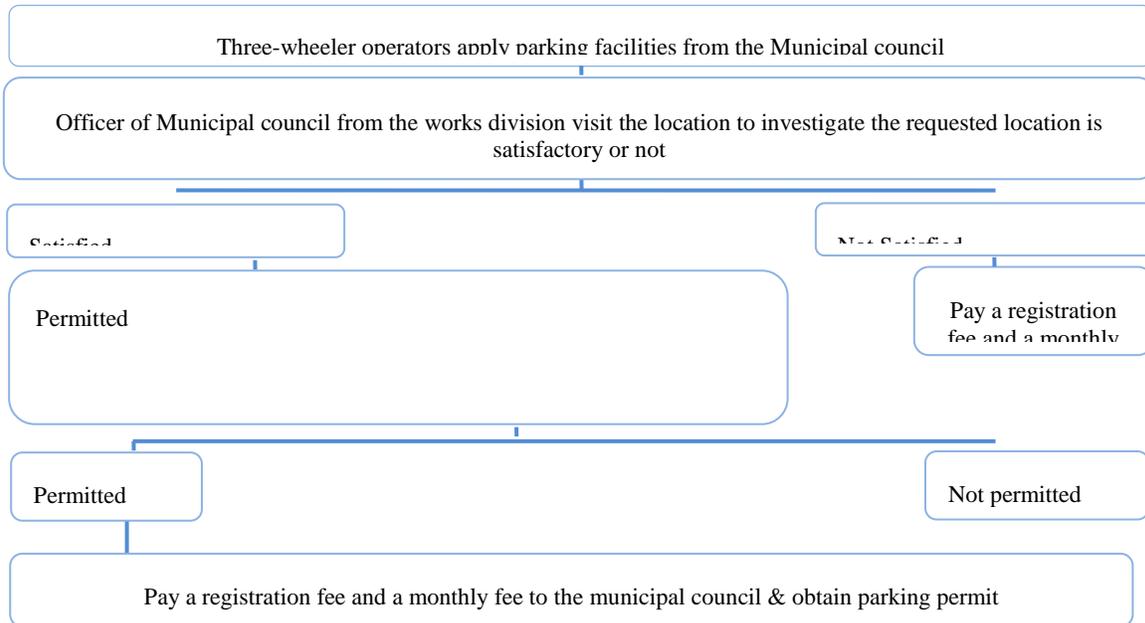


Figure 2 – Procedure adopted for permitting three-wheeler parks

It’s seen that when permitting three-wheeler parking near road intersections effects on pedestrians, vehicular flow, and reduction of carriageway widths etc. are not considered.

Accident details

Past accident records from *Kandy, Mirihana and Matale* police stations indicate that there is a considerable increase of accidents at all locations after implementing three-wheeler parks.

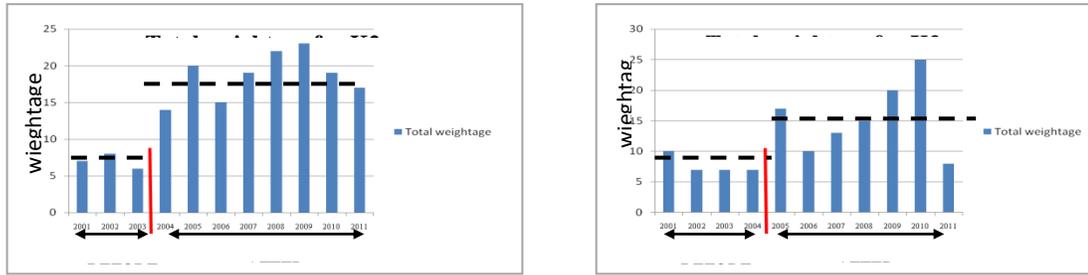


Figure 3 – Accident weightage for K2 and K3 locations

Traffic surveys

The traffic surveys were conducted for three hours at each location, to study the traffic flow patterns at all the 5 selected study locations. The exit rates and the vehicular delays of the studied intersections were calculated by using the data collected from the traffic surveys by using Tanner model (1962). Data collected from traffic surveys as follows:

- Major and minor road flow - The number of vehicles in traffic flows of major and minor roads was collected. All the counts were done in 5 minutes intervals.
- Identification of minimum following time of major road vehicles (β_1)- Time headway between the front and rear vehicle of bunch of vehicles which are following each other were observed when passing a selected point on the road. The number of vehicles which were included in each bunch was also counted separately. This was carried out for 100 samples at each location. Then the average time headway was calculated.
- Number of vehicles entering the major road - Number of vehicles which were entering the major road was observed in 5 minutes intervals.
- Vehicular delay - Registered number of each vehicle and the time was recorded when it joined the minor flow vehicle queue, and when it entered the major flow respectively. The difference of the above mentioned times were calculated to find the delay of each vehicle.
- Number of three-wheelers - Number of three-wheelers parked in the three-wheeler park was recorded at each 5 minutes interval.

ANALYSIS

Exit rate and average delay analysis

Exit rate - number of vehicles per hour in a minor stream that can enter a major stream was calculated using the following equation which was developed by the Tanner (1962).

$$C = 3,600 \frac{q_p e^{(-q_p t_a)}}{1 - e^{(-q_p t_f)}}$$

Where, C = the exit rate from minor road

q_p = the major (priority) stream volume in veh/sec

t_a = the critical acceptance gap in seconds

t_f = the follow-up headway in seconds

Average delay-Tanner’s formula for the average delay to minor road vehicles due to the vehicles on the major road, when the system is in statistical equilibrium was used to calculate average delay at each intersection is as follows.

$$w_2 = \frac{1/2E(y^2)/Y + q_2Ye^{(-\beta_2q_1)}[e^{(\beta_2q_1)} - \beta_2q_1 - 1]/q_1}{1 - q_2Y[1 - e^{(-\beta_2q_1)}]}$$

Where,

$$Y = E(y) + 1/q_1$$

$$\beta_2 = \frac{112.02}{100}$$

$$E(y^2) = \frac{2e^{[q_1(t_a - \beta_1)]}}{q_1^2(1 - \beta_1q_1)^2} e^{[q_1(t_a - \beta_1)]} - t_aq_1(1 - \beta_1q_1) - 1 + \beta_1q_1 - \beta_1^2q_1^2 + \frac{1}{2}\beta_1^2q_1^2 \frac{1}{(1 - \beta_1q_1)}$$

q_1 = arrival rate on major road

q_2 = arrival rate on minor road

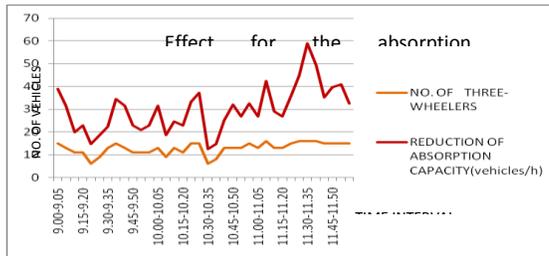
β_1 = minimum following time of major road vehicles

β_2 = move-up time of minor road vehicles

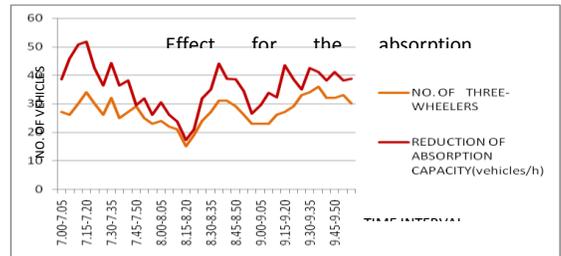
t_a = critical acceptance gap

RESULTS AND DISCUSSION

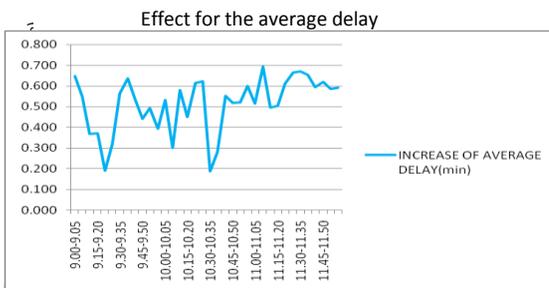
According to the results there is a considerable reduction in exit rate and increase in average delay. When the number of parked three-wheelers increased, reduction of exit rate and increase in average delay was noticeable (see Figure 4).



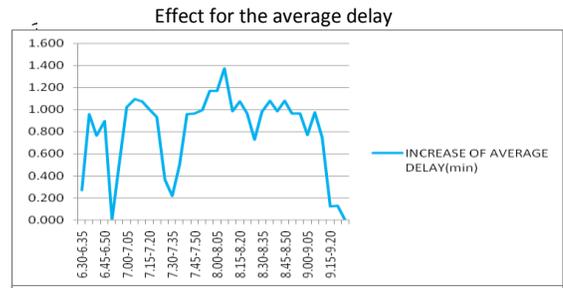
K1 study location



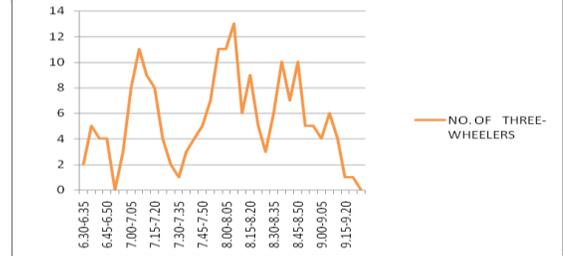
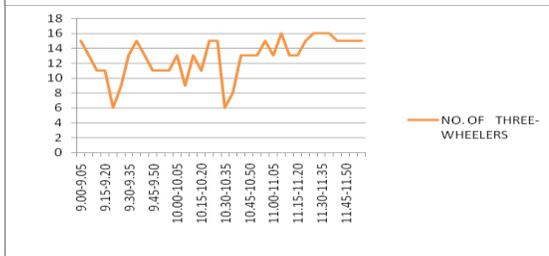
K2 study location



K1 study location



K3 study location



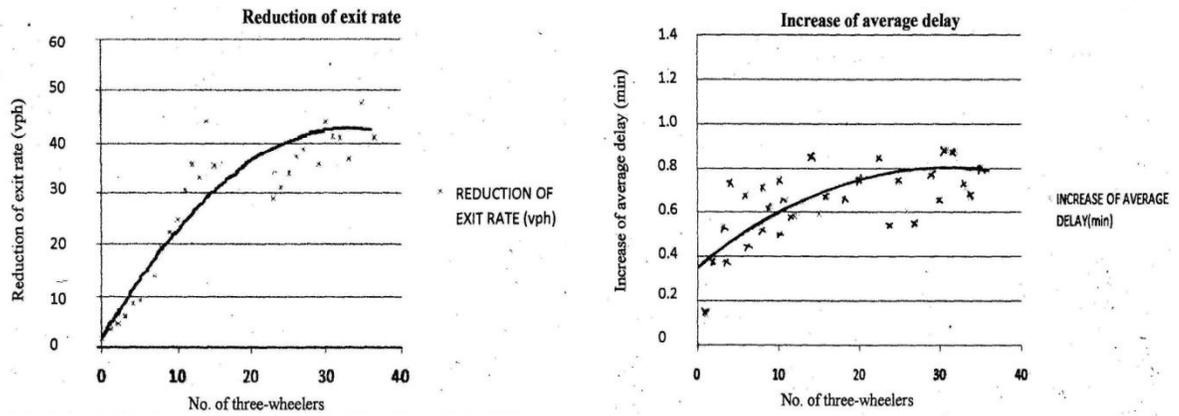


Figure 4- Effect on exit rate and average delay

CONCLUSIONS

This study confirms that three-wheeler parks near intersections do have an impact on average delay and exit rate from minor road vehicles. There was an increase in the average delay and a reduction in exit rate for vehicles on minor roads when three-wheelers park near intersections.

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METHODOLOGY FOR JUSTIFICATION OF OVERHEAD PEDESTRIAN CROSSINGS USING SPEED CHANGE CYCLES

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INTRODUCTION

When a vehicle is traveling at its cruise speed, if the speed is interrupted due to change of road geometry, road features or any road event (such as lane reductions, presence of road intersections, interruptions due to pedestrian crossings etc.), it will decelerate to a minimum speed (which even can be a complete stop) before accelerating back to its original cruise speed. It can be said that a vehicle undergoes a speed change cycle which leads to a difference in travel time and Vehicle Operating Cost (VOC) for traveling the distance of the speed cycle at the original cruise speed versus reduction of speed through the speed cycle.

The study location was selected in front of the Malabe Campus of the Sri Lanka Institute of Information Technology (SLIIT) along the Malabe - Kaduwela road with an Average Daily Traffic (ADT) of 39,800 vehicles per day. At this location, traffic flow is constantly obstructed by the existing pedestrian crossing at the entrance to the Malabe Campus of SLIIT. This is a straight stretch of road consisting of minimum disturbance to traffic except for heavy pedestrian crossing movement that takes place in the location. With this very high ADT value, reduction and regaining the speed of vehicles may cause additional VOC and also increase travel time, higher accident risk, increase in vehicular emissions etc. finally causing huge additional cost to the national economy annually. Hence the additional cost for more fuel and oil consumption, wastages of tires, wear and tear of mechanical parts, additional travel time etc. could be quantified. As a solution, a safe overhead pedestrian crossing structure is designed and the construction cost is compared with the savings from the reduction in travel time and VOC, and finally, the construction of the structure is justified by carrying out a cost benefit analysis.

METHODOLOGY

Step1: Traffic survey

Firstly, traffic flow pattern around the study area was measured. Vehicles were counted manually on both directions at 15 minute intervals. Two directional vehicular flow for 24 hours is as shown in Figure 1. Peak hours were identified as; morning peak from 7:00 to 8:00am, mid-day peak from 1:00 to 2:00pm and evening peak from 5:00 to 6:00pm.

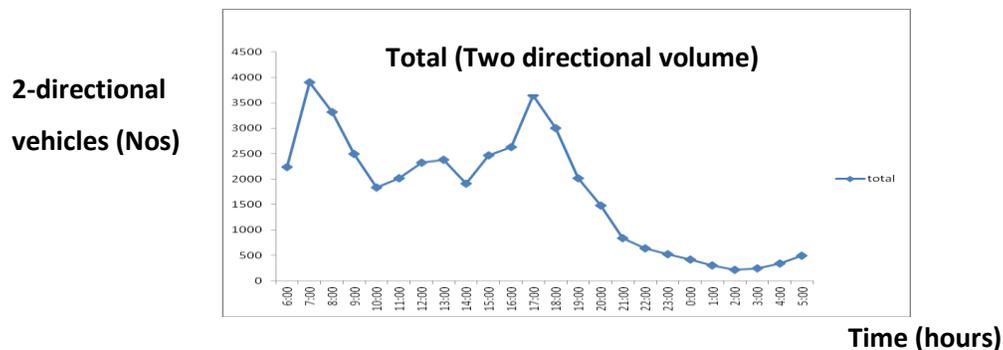


Figure 1 – 24 hour vehicle distribution

Step2: Pedestrian survey

Secondly, pedestrian crossing flow around the study area was measured. A pedestrian count at the entrance to the SLIIT was done at 5 minute intervals throughout the day, in order to identify the pedestrian peak hours. Two directional pedestrian crossing flow is as shown in Figure 2. Pedestrian crossing peaks were identified as; morning peak from 7:45 to 8:45 am, mid-day peak from 12:45 to 1:45 pm and evening peak from 4:55 to 5:55 pm.

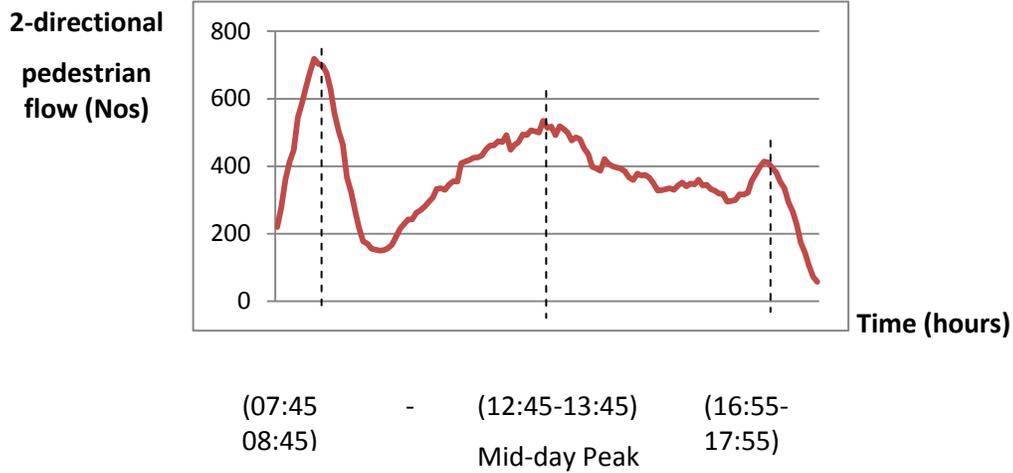


Figure 2 – Two directional pedestrian crossing flow

Step 3: Traffic volume study

As per two directional traffic volume, 7 time slots were selected to carry out the speed profile study as indicated in Figure 3. The study analysis was carried out under the following assumptions. It was assumed that vehicular flow pattern and vehicle composition at the study location is the same for all 7 days throughout the year. It was also assumed that flow pattern changes due to weather changes and the peak hours would not vary. Seasonal variation of traffic at the study location has been ignored.

To generate average speed profiles the time slots were taken as follows (see Figure 3): 6.00am - 8.00am, 8.00am - 9.00am, 9.00am - 12.00 & 1.30pm - 3.30pm, 12.00 - 3.30pm, 3.30pm - 6.30pm, 6.30pm - 10.00 pm and 10.00pm - 6.00am.

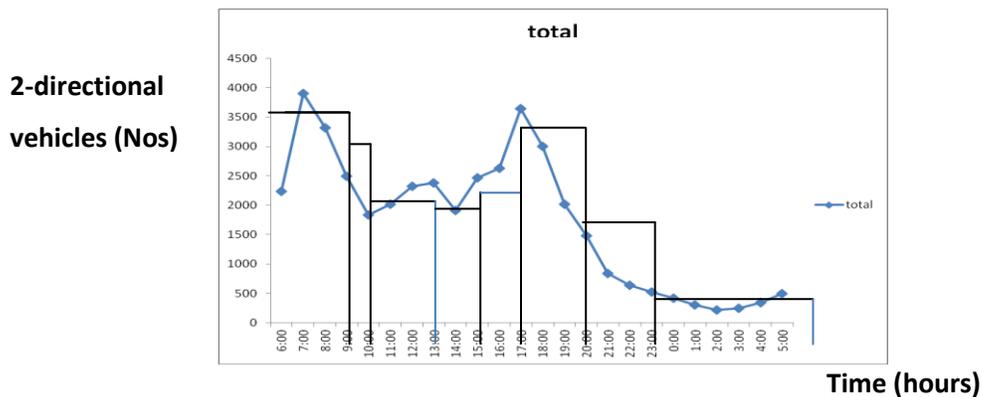


Figure 3 – Time slots based on two directional traffic volumes

Step4: Speed measurements

As shown in Figure 4, either side of the existing pedestrian crossing was divided into 10m sections for taking speed measurements. Speeds of random 25 vehicles (from all vehicle categories) were measured in every 10 m road segment. In addition, the average speed was measured 100 meters away from the pedestrian crossing along both sides. Average speed variation for all categories of vehicles during each time slot (for both directions) was recorded and corresponding speed profiles for each time were drawn.

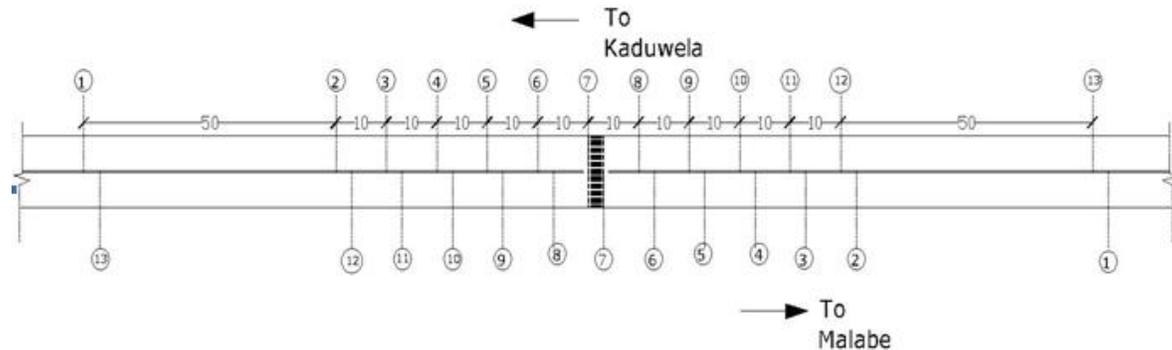


Figure 4 – Speed measurement locations

Step 5: Determination of additional vehicle operating cost (VOC) and additional travel time for a speed change cycle

The additional vehicle operating cost for speed change cycles of each vehicle category were taken by using the VOC tables obtained from NZ Transport Agency's Economic Evaluation. Within the selected time slots additional VOC for each vehicle class were computed for both directions. Hence total additional VOC values per day (due to speed change cycle) for all classes were computed.

The additional travel time for a speed change cycle is the difference in travel time for traveling the distance of the speed cycle at the original cruise speed from reduced speed through the speed cycle. The road user values are used to produce travel time values for uncongested and congested traffic conditions. Hence with the help of speed change cycles, savings on VOC and travel time were computed on annual basis due to the construction of the overhead pedestrian crossing.

Step 6: Design of the overhead pedestrian crossing

Based on the pedestrian survey results the overhead pedestrian crossing structure was designed. The span of the structure was decided based on the designed carriageway width of the road for a projected traffic for 20 years from now. The width of the structure was determined according to the forecasted pedestrian volume after the same period of time for a Level of Service (LOS) of C (Highway Capacity Manual, 1985). Vertical clearance was decided based on RDA standards (RDA, 1998). Design of the structure was done as a combination of pre-stressed and reinforced concrete.

Step7: Cost estimation

As described in step 5 the total additional VOC per a typical day for all vehicle classes as they undergo a speed change cycle due to the existing pedestrian crossing was computed. At the same time, for the same speed change cycle, additional travel time per day for all vehicle classes was

determined (NZ Transport Agency). The total cost for additional travel time for all vehicles classes was calculated by considering the annual income of different road users. The additional cost on the system (due to total cost for additional travel time, total cost for fuel and oil wastage, total cost for tyre wastage, total cost for maintenance and repairs, and total cost for depreciation per day) can be computed on annual basis. Then by predicting for future time periods by taking in to account the traffic growth rate in Colombo district the final total cost was computed. The construction cost of the overhead pedestrian crossing was computed separately.

Step 8: Economic evaluation

By comparing the various methods available for economic evaluation, Internal Rate of Return (IRR) method was selected to conduct the economic evaluation of this study. The IRR is the discount rate which makes the discounted future benefits equal to the initial outlay. In other words, it is the discount rate which makes the stream of cash flow to zero. IRR was picked to carryout the analysis after considering all the merits and demerits of the other available economic evaluation methods.

RESULTS AND DISCUSSION

Total cost of the project and cost saving from the new structure are as follows:

Total construction cost of project (as per year 2012)	=	Rs.124, 000,000
Cost saving from additional VOC (per day)	=	Rs. 59,260
Cost saving from additional travel time (per day)	=	Rs. 38,165
Cost saving per year 1 (Rs. 59,260 + Rs. 38,165) x 365	=	Rs. 35,560,125 → (Rs. 35,560,000)

Expected IRR of this project is 13.4% and it should be compared with the minimum rate of return applicable to make an investment decision. The proposed overhead pedestrian crossing will cost 124 million rupees in 2012 and it is expected to save 35.56 million rupees per year over the next 5years. Hence it can be seen that the construction cost could be recovered in less than 5 years

CONCLUSIONS AND RECOMMENDATIONS

It was shown that the best possible way to ensure reduced VOC and safe travel along this road stretch for commuters was by constructing a new overhead pedestrian crossing. The proposed width of 2 meters of the overhead crossing structure will serve the forecasted pedestrian volume at a reasonable LOS, even twenty years from now. At present capacity of Malabe - Kaduwela road is not adequate, and improvement is needed to overcome the anticipated future traffic congestion along this road section by improving up to 4 lanes. With suggested improvements initially the LOS of the road will improve considerably, but in twenty years time it will reach the present level of service of the road if present traffic growth rates persist. As the IRR of this investment exceeds its cost of capital (10% - 12%), the project can be undertaken. This project is considered to be profitable and execution of the project is justified.

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Road Development Authority of Sri Lanka (1998), Geometric Design Standards of Roads.

**COMMUTERS' PERCEPTION AND TRANSPORTATION ALTERNATIVES ANALYSIS
FOR MITIGATING MORNING PEAK HOUR TRAFFIC CONGESTION
A CASE STUDY FROM KOTTAWA TOWARDS THE CAPITAL COLOMBO WITHIN 20
KM DISTANCE**

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INTRODUCTION

Morning peak hour traffic congestion is now an escalating social, economic and political problem, as delays on roads and costs associated with these delays are steadily increasing. Thus an efficient and high quality public transport system capable of retaining existing customers as well as attracting private vehicle users has become an urgent need. The focus of this study was therefore to highlight some major causes responsible for morning peak hour traffic congestion and how commuters make travel decisions with respect to different public transport service quality attributes and related factors.

METHODOLOGY

Data Collection

This study was conducted as a case study on the 138 bus route, along the High-level road, towards the direction of Colombo city starting from Kottawa. This narrows the very broad field of investigation into a researchable topic. As the initial part of the study a 'supply survey' which included a number of traffic and transportation surveys along with secondary data collection was conducted. This enabled a better understanding about the vehicle and passenger movement patterns, travel characteristics and available infrastructure within the study area. The data collection activities in the 'supply survey' included 'Travel speed survey (locating high accessible nodes along 138 bus route)', 'road inventory survey (assessing physical characteristics and condition on the road)' and 'traffic counting survey (identifying the vehicle composition at Kottawa junction)' and each was carried out over a period of 3 months from May, 2012 to July 2012. In addition, significant data from secondary sources pertaining to the current traffic volume within the country was also collected as a part of the data collection process.

The second phase of the study (questionnaire survey) was conducted to examine prevailing passenger transport demand, drawbacks and viable improvements required for the existing public bus transport system with special reference to the 138 bus route. Locations for recruitment were chosen based on convenience and respondents were selected through non-probability quota sampling taking a predetermined quota on primary transport mode of choice to commute into account. 500 questionnaires were filled out and 472 were accepted as the study sample.

Data Analysis

Data analysis was performed using SPSS 16 and R version 2.13.2 (2011-09-30). The analysis was conducted in four steps. In the initial stage, descriptive analysis was performed for the data obtained from both observational studies and questionnaire survey to obtain a general summary. Principle Component Factor Analysis (PCFA) with varimax rotation was then performed with the aim of grouping the five point Likert-scale variables into a small number of interpretable factors. To make sure that the correlation matrix was appropriate to produce a factor structure not found

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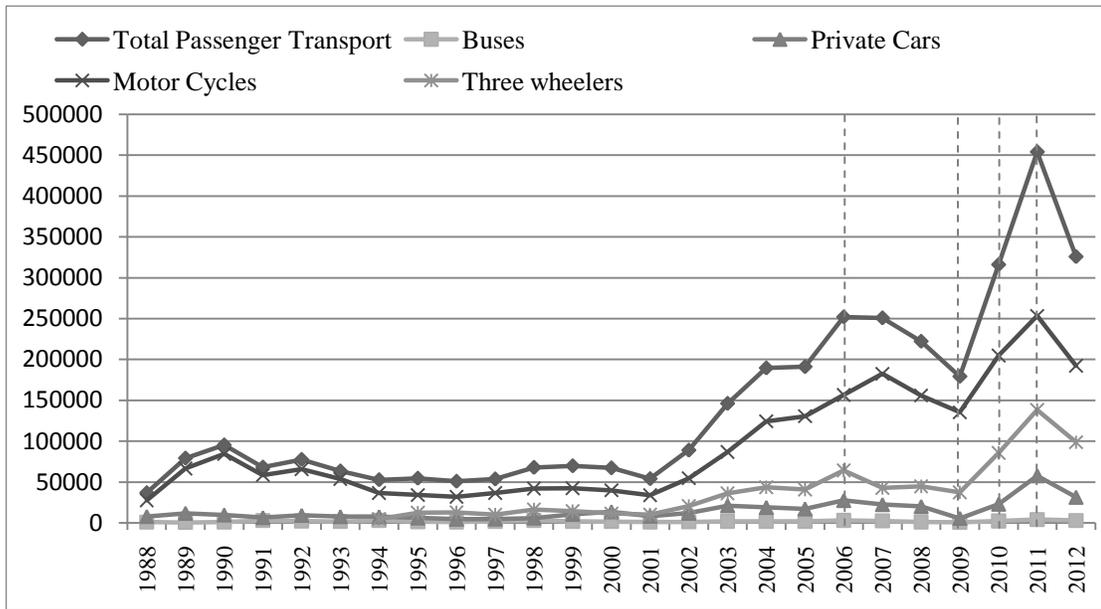
by chance, a visual examination of the correlation matrix followed by a Bartlett’s test of sphericity and Kaiser-Meyer-Olkin (KMO) tests were carried out. Factor extraction involved the Kaiser’s criterion, the scree test, and parallel analysis (Hayton et al. 2004) in determining the number of factors to be retained for interpretation. Following the guidance of Lattin et al. (2007), assuming that the data in the sample are representative of the underlying population, bootstrap validation method was then used to assess the validity of the results from the PCFA.

Third, bi-variate test of association (Kruskal Wallis Test and Bootstrapped One-Way ANOVA) was conducted to explore the relationship between the study variables and the derived factors.

Finally, the factors derived from the PCFA were further analyzed using multidimensional scaling analysis. This was done in order to create a map of the locations of the factors in reference to each other, based on their similarities and dissimilarities.

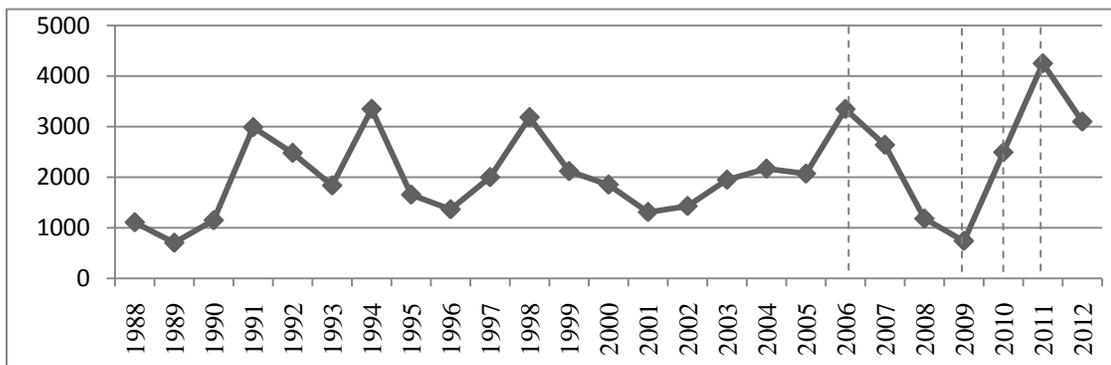
RESULTS AND DISCUSSION

Figure1: New Registration of Passenger Transport Vehicles in Sri Lanka 1988 – 2012



Source: Department of Motor Traffic

Figure 2: New Registration of Buses in Sri Lanka 1988 - 2012



Note: 2006 - 2009: Critical war period

2009 - 2010: Post war

2010 – 2011: Government cut import taxes on vehicles and also gave reduced-tax permits to state sector employees in June 2010.

2011 – 2012: Government increased the import duty of vehicles to discourage imports (However there has been no change in the tax imposed on commercial vehicles such as tractors, buses and Lorries)

Figure 1 depicts a disaggregated analysis of new registrations of ‘passenger transport vehicles’ in Sri Lanka. It clearly illustrates that the increase of total passenger transport vehicles is mostly created by private vehicles (three-wheelers, motor cycles and private cars) compared to public vehicles. Figure 2, depicts an attempt to analyze the new registration of ‘Buses’ in Sri Lanka. Since there has been no change in the tax imposed on commercial vehicles such as tractors, buses and lorries special attention should focus on identifying the causes behind the sudden drop of new registration of buses in 2012.

Results through ‘travel speed survey’ and ‘road inventory survey’ highlighted that the number of schools, traffic lights, incoming access road to main road from both the left side and the right side have a significant impact on morning peak hour traffic congestion on working days. ‘Traffic Counting Survey’ carried out at Kottawa junction, highlighted that the public transport share at Kottawa junction toward the direction of the city of Colombo along the high-level road during the peak period is only around 6 percent, though it serves almost two thirds of the total travel demand. In contrast, over 90 percent of the road space is used by private and hired vehicles while serving only 35 percent of the total travel demand.

Further, from the central tendency findings it is reported that the existing public bus transport system is not satisfactory from both private vehicle users and existing customers’ perspective. A majority of the commuters, those who use private vehicles as their primary transport mode of choice to commute, have pointed out that inconvenience, lack of seating facilities and delays are the major reasons which discouraged them from using public bus transport. Another important point to emphasis is that, the majority of present public transport users utilize public transport service not because they consider it as a good alternative for private vehicles, but due to unavailability of own vehicle and less cost involved.

Principal component Factor analysis which was used to reduce the number of specific attributes in to smaller dimensions, pointed out any action taken to encourage a mode shift to public bus transport should address six broad areas.

The first factor was clearly the most important one since it accounted for the highest portion of the total variance and consisted of eight items. All items in this factor referred to the importance attached by the commuters towards time related attributes and the service offered by crew members, conductors and bus drivers and was therefore named as ‘punctuality and service reliability’. Further, investigations also revealed that irrespective of the level of individual characteristics, a majority of the respondents attached high importance to this factor.

The second factor consisted of three items, which was summarized as the expenses and economic related attributes and was therefore named as ‘Price conscious’. More disaggregated analysis revealed that high expenses involve in using their own vehicles encourage them to commute by bus. Further, test of associations revealed that monthly household income and marital status had a significant impact on this factor.

The third factor: 'Easy accessibility' consisted of four items. In this factor, the first two items were about easiness of reaching the bus service whereas the remaining two were about easiness of reaching the work place. A significant association was found between the age of the respondent and the level of importance they attached to this factor. As was expected elders who were 55 or above were more concerned about this matter. It further revealed that 'easy accessibility' is one of the most expected attributes from a better service by private vehicle users.

The fourth factor which was composed of four items reflected the commuters' perceptions towards the comfort in the bus, cleanliness, seat availability and sense of independence while travelling and was therefore labeled as 'On board comfort'. A significant difference was found with respect to monthly house-hold income where high income earners were more concerned about on-board comfort than others. Not surprisingly, a difference was also found with respect to primary transport mode of choice. Both private vehicle users and office provided staff bus users have attached high importance toward this factor than public vehicle users.

The fifth factor: 'Safety and security' summarized three items referring to parking place security and personal security. The two attributes with high positive loadings indicated that introducing safe and secure parking lots encourage commuters to shift to bus services, placing their own vehicle at a parking lot. Further investigation also revealed a significant difference in relation to this factor with respect to type of work place. Workers from private, semi government and banking sectors were more concerned about these safety issues than others

The last factor 'Special services and features' consisted of only two attributes related to the importance attached by the commuters toward 'special bus services only for ladies' and 'extra comfort features like A/C, TV facilities and daily newspapers'. A significant difference was found with respect to gender, where female commuters place more importance on this factor than male commuters.

The second PCFA was carried out to guide the research in relation to the objective: "To propose possible alternative solutions to reduce the morning peak hour traffic congestion, from commuters' point of view". This resulted five factor solution named 'Control Access', 'Law and driver education' 'Infrastructure development and maintenance', 'Parking management' and 'Improving bulk carrier public transport systems.

Further analysis revealed that compared to the other three aspects, 'Parking management' and 'Improving bulk carrier public transport systems' have lower priority among the commuters. These findings highlight the necessity of well organized public awareness programs to improve public understanding on how these actions could assist their protection. Multi dimensional scaling analysis further simplified these resulted factors in to broader areas for planning and actions.

To conclude, the outcomes of the study highlight some perceptions and expectations of the commuters and different aspects of the public transportation system affecting the performance of the system as a whole. Therefore, the findings and recommendations of this study will be very useful in planning both the road system and the public bus transport system. This will help in reducing the congestion problems one step ahead before the situation gets worse. Further it is hoped that this study will stimulate further research into this important phenomenon.

RECOMMENDATIONS

It is also important to draw attention to some limitations associated with the study. First, this study was conducted as a case study since it narrows the very broad field of investigation into a researchable topic. However as is the nature of a case study, the research questions are difficult to answer completely as it will not be generalizable due to the narrow focus.

It will thus generate indications that could be used for predictions or as a hypothesis for future investigations. Future studies should therefore recruit a higher number of respondents in a wider area in Sri Lanka. Further, due to lack of resources and technology, manual counting was used to collect traffic data. However the use of this traditional method for collecting data is necessary but not sufficient due to their limited coverage. Automated counting can be used parallel to the manual traffic counting process.

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IMPROVEMENTS TO THE RADELLA IRRIGATION SCHEME IN LAHUGALA DIVISIONAL SECRETARY AREA IN AMPARA DISTRICT

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INTRODUCTION

Tank irrigation systems contribute significantly to agricultural production in the dry zone of Sri Lanka. Tank irrigation has a long history and many currently used tanks were constructed in the *Anuradapura* and *Polonnaruwa* era. Four rainfall seasons can be clearly identified in Sri Lanka from which two consecutive rainy seasons make up the major growing seasons, namely *Maha* and *Yala*. *Maha* season is the major growing season while *Yala* is considered the minor growing season of the dry zone. Tank irrigation contributes mainly during *Yala* season where the farmers are unable to cultivate due to insufficient amount of water that they receive from rain in spite of the land availability.

The *Radella* scheme is situated very close to “*Heda Oya*” River in *Radella* village in *Lahugala* Divisional Secretary area in *Ampara* District in the Eastern Province. The left bank end of the main bund is defined by the co-ordinate (181925N, 308575E). This is an ancient tank built to accommodate drainage water from its own catchment. In 1995 the tank bund was breached due to heavy floods. In January 2000 the dam breached in three locations, once again due to heavy floods and overtopping of the bund. After restoration, presently 405 ha extent of land is under paddy cultivation in *Maha* season, where as the paddy cultivation varies according to the water availability (Figure 2).

In *Radella* scheme, most of the farmers cultivate only in *Maha* season due to the problem of getting sufficient water during the *Yala* season. Some farmers do not get sufficient water for the final stage of paddy cultivation even in *Maha* season. This eventually decreases the yield even in *Maha* season. The social and economic condition of the farmers in the scheme is extremely pathetic. Most of them have taken loans from either government banks or private institutions. The loans are repaid with the harvest that they get in *Maha* season, leaving them in a “no saved money” state once again. Two solutions can be adopted in solving the above problem; encouraging the farmers to cultivate in *Yala* & improving yield in *Maha*. This study mainly focuses on increasing the cropping intensity during *Yala* season facilitating the farmers to

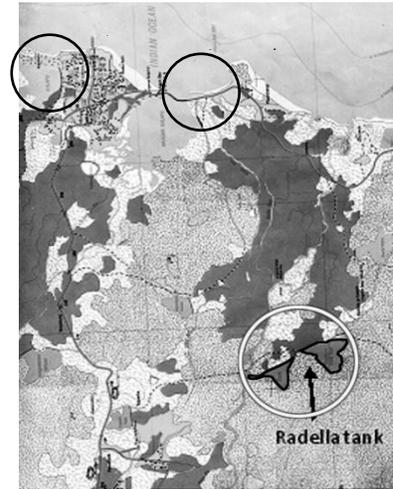
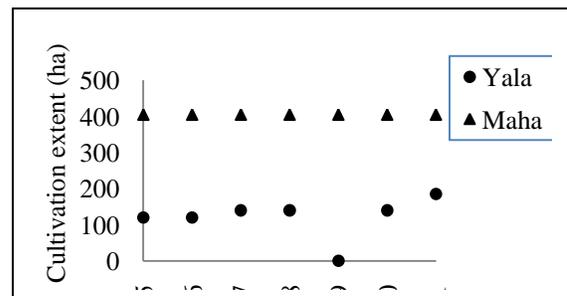


Figure 1 - Dattivil area



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improve their economic and social conditions in the long run. The main shortcoming of the scheme is that the tank water is not distributed to all the paddy fields in the *Radella* Irrigation scheme because the sluice of the tank is situated at a lower level than some of the paddy fields. These paddy fields are situated in such a manner that water cannot be taken from any other water source. Other reason leading to fewer yields is that the water capacity of the tank is insufficient for distribution among all the paddy fields. According to figure 2, an average extent of 140 ha of land has been cultivated in *Yala* season since year 2005 except for year 2009 where no cultivation was carried out due to the severe drought.

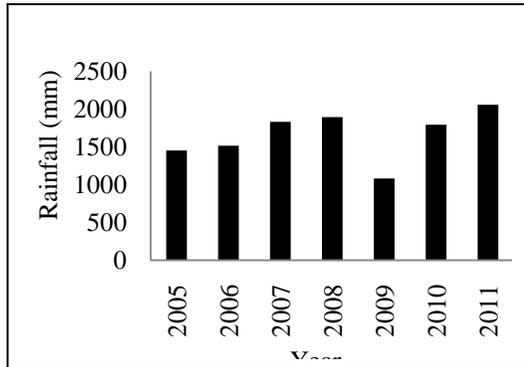


Figure 3 – Rainfall data in *Radella* tank

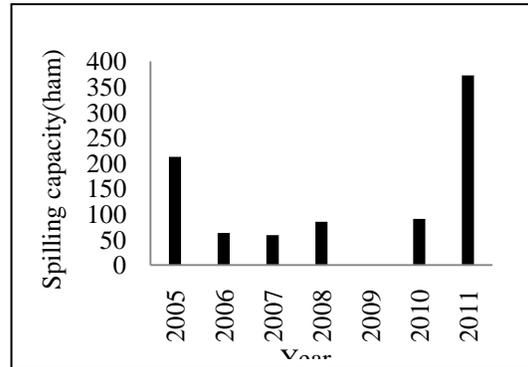


Figure 4 – Spilling capacity data in *Radella*

It can be observed from figures 3 & 4 that the tank spills annually as a consequence of heavy rains in the months of December and January except for year 2009.

AIM

The aim is to redesign the *Radella* tank bund and the spill in view of increasing the cropping intensity of the *Radella* Irrigation Scheme.

OBJECTIVES

Perform an operation study and redesign the tank bund

- Raise the sill level of the sluice.
- Perform a flood study and redesign the spill.

METHODOLOGY

Operation Study

An operation study was carried out to determine the optimum water capacity of *Radella* tank and possible irrigable land with paddy in *Maha* and paddy and other desired crops in *Yala*. The study is started by assuming a nominal storage and proposed extent of cultivation area. A pre-determined cropping pattern and intensity were decided at the beginning of the study.

“Water balance equation” shown below is the basis of the operation study.

$$\text{Storage at the beginning of the } \dots + \text{Inflow} - \text{losses} - \text{Demand} - \text{Spillage} = \text{Storage at the end of the } \dots$$

The procedure in carrying out an operation study is given in the block diagram shown in Figure 5.

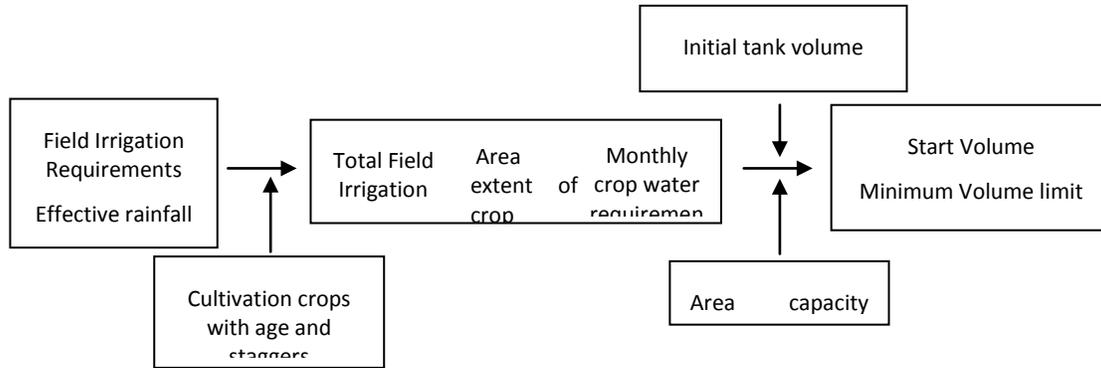


Figure 5 – Block diagram for operation study

Flood study

Intensity- Duration – Frequency curves have been derived for the 6 hydrological zones into which Sri Lanka is divided. These curves could be obtained using equation 1 (Ponrajah,1984).

$$I = XD^{-Y} \tag{1}$$

where I = The rainfall intensity in mm per hour, D = Duration in minutes, X , Y = Constant for each curve. The rainfall intensity is obtained considering that Radella tank is situated in hydrological zone 6 (Ponrajah, 1984).

The peak run-off from a catchment which has no undue retention or detention occurs when the storm is of duration equal to the time of concentration of the catchment and the run – off can be obtained by the Rational formula given in equation 2 (Ponrajah,1984).

$$Q = RICA \tag{2}$$

where, Q = Peak runoff in meter cube per second, R = Coefficient dependent on the units used, C = The runoff coefficient, I = The rainfall intensity in mm per hour, A= The catchment area in hectares.

Time of concentration can be can be calculated using equation 3 (Ponrajah,1984).

$$T_c = \frac{L}{60V} + 15 \text{ minutes} \tag{3}$$

where, T_c = Time of concentration in minutes, L = Longest watercourse in meter, V = Average velocity in meter per second.

Capacity of spilling (Qo) and Duration of spilling (Ds)

Capacity and duration of spilling can be obtained using Figure 6.

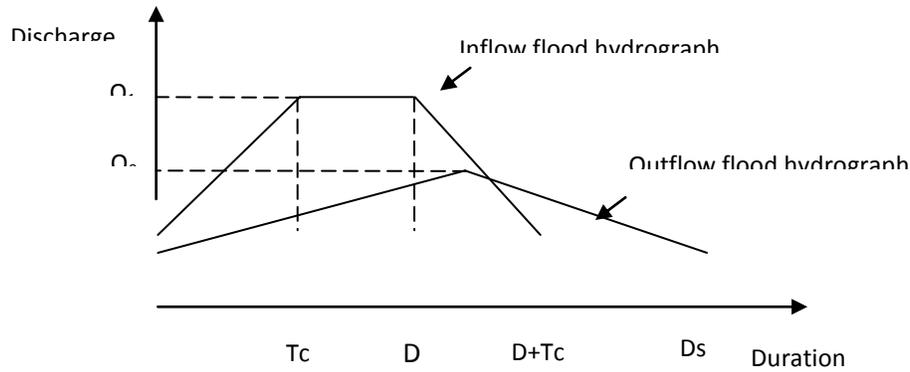


Figure 6 – Inflow & outflow flood hydrographs

when $D = T_c$
$$Q_o = Q_1 - \frac{Q_D}{0.36T_c} \tag{4}$$

when $D > T_c$
$$Q_o = \frac{2DQ_1}{(D + T_c)} - \frac{2Q_D}{0.36(D + T_c)} \tag{5}$$

$$D_s = 2T_c + \frac{2Q_D}{0.36T_c} \tag{6}$$

Where Q_1 = Maximum run off in meter cub per second, Q_o = Critical out flow in meter cub per second, T_c = Time of concentration in hour, D = Duration of rainfall in hour, D_s = Duration of spilling in hour, Q_D = Detention capacity in hectare meter

Length of the spill

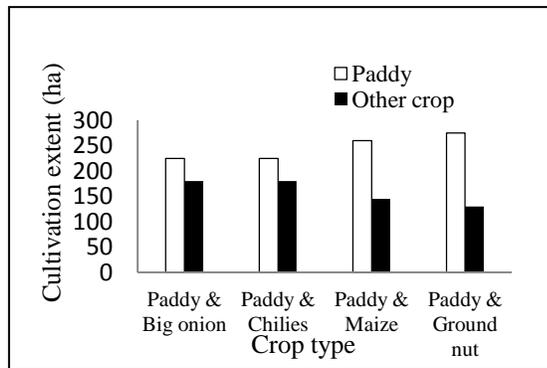


Figure 7- Cultivation extent Vs crop variety in Yala season

Length of the Clear overfall spill was obtained using equation 7 (Ponrajah, 1984).

$$Q = 1.83 L H^{1.5} \tag{7}$$

where, Q = Critical out flow in hectare meter, L = Length of the Clear overfall spill in meter,

H = Afflux in meter.

Soil sampling and analyzing

Soil was sampled from several locations of the paddy fields in *Radella* scheme and tested using sieve analysis and hygrometer tests to check the suitability of soil for cultivation.

Survey work

Radella tank was surveyed in several aspects to obtain necessary technical data. Survey work included leveling of the tank bund, bed contour survey, identifying the longest fetch and taking levels in the paddy fields in the vicinity of the tank.

RESULTS AND DISCUSSION

From the Operation study the tank capacity was found to be 490 ham. Using elevation-area-capacity data of the *Radella* tank, it can be suggested that the tank full supply level be increased by 1.5 m to accommodate the increased water capacity. Consequently, crest level of the spill should be raised by 1.5 m. Using the levels obtained via survey work carried out in the *Radella* tank, it was determined that the sill level of the tank sluice should also be raised by 0.9 m to facilitate distribution of water for all the paddy fields in the *Radella* Irrigation scheme. Therefore the dead storage must be increased from 13 ham to 50 ham. Spill length is increased from 30 m to 36 m. The extent of area that can be cultivated in *Maha* and *Yala* seasons are 405 ha and 325 ha respectively after adopting the suggested improvements.

By introducing new variety of crops with low water consumption (eg: *maize*, *chilies*...), the paddy extent can be reduced, facilitating cultivation of whole 405 ha even in the *Yala* season (Figure 7).

CONCLUSIONS

The increased water capacity in the *Radella* tank can be used to irrigate more paddy lands in *Radella* irrigation scheme during *Yala* season. As the sill level of the sluice is raised to the maximum ground level of the paddy lands, all the paddy fields will get water both in *Maha* and *Yala* seasons. The extent of area that can be used for paddy cultivation in *Maha* and *Yala* seasons are 405 ha and 325 ha respectively, after adopting the suggested improvements. By introducing new variety of crops with low water consumption, all culturable land in *Radella* Irrigation scheme can be cultivated even in *Yala* season. The chances of depletion of *Radella* tank is minimized due to the increase of dead storage.

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TUTORS' PERCEPTIONS OF THE EFFECTIVENESS OF THE SPEECH AND LISTENING SHORT COURSE IN ENGLISH FOR SCHOOL LEAVERS IN SRI LANKA

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INTRODUCTION

The growing need for effective communication skills in English has created a demand for quality English language teaching, and quality English language materials and resources. This is especially important in the Sri Lankan context seeing that employability and fluency in English language skills are intrinsically linked (Perera, Silva & Marambe, 2009, Wipulasena, 2013, Youth Employment Network, 2007). Under these circumstances, in 2011, the Ministry of Education of Sri Lanka decided to empower students who have gained entry to universities in Sri Lanka by conducting a Pre-Orientation Programme (POP). The course content attempted to develop their leadership skills, proficiency in English and IT skills. The success of this course prompted the Ministry of Education of Sri Lanka to offer a similar programme: "Education for Knowledge Society Project" (EKSP) to students who have passed the G.C.E. A/L examination but could not gain entry to universities to make them employable. This project included a short course in English and Soft skills in 9 provinces of Sri Lanka. The Department of Language Studies of the Open University of Sri Lanka was selected to offer students a short course in Speech and Listening. The course is of 03 months duration; 5 hours per session, and offered to batches of 30 to 40 students consecutively over a one year period. The course commenced in January 2012 and classes were conducted in 16 Regional and Study centres of the Open University of Sri Lanka. Teachers from 9 provinces of Sri Lanka who have experience in conducting the Pre-Orientation Programme for University entrants in 2011 were employed to teach in the course.

The Short Course in Speech and Listening aims to develop the English Speech and Listening skills of learners at basic proficiency level. Learners are provided with a Course Book comprising 10 lessons accompanied with a CD containing listening dialogues and activities focusing on functional areas that the learners encounter in daily life. Also included in the Course Book are speech practice activities. Hand-outs containing supplementary activities are also provided to learners; tutors are provided with CDs containing songs to be used during class sessions to give learners further practice in developing speech and listening skills.

The Department of Language Studies has made a consistent effort to upgrade and revise its courses to meet the needs of its students. With this in view an evaluation of this course was deemed necessary. The evaluation of an educational programme according to Steele (1970) needs to take into account five aspects: *quality, suitability, effectiveness, efficiency, and importance*. Steele (ibid) further explained that these five aspects take into consideration the content, learning activities, the media, the difficulty level of the tasks, whether the programme reached its desired expectations, learner satisfaction and the accomplishment of the objectives of the programme with the available resources. Ellis (1997) added another important aspect; that a retrospective evaluation of course material is important since it sheds light on whether the course material can be reused or revised, which tasks work and which do not. Endorsing this view Tomlinson (1998) states that in order to cater to the needs of second language learners (L2), it is not sufficient for learners only to enjoy and value the material but it is also necessary that the learning procedures ensure that the learners actually learn what they want and need to learn.

Therefore, Tomlinson (ibid) advises that an effort must be made to strive towards the development of materials that will give learners satisfaction and success.

Therefore, the purpose of this study was to examine the effectiveness of the Short Course in Speech and Listening that was designed for school leavers.

RESEARCH QUESTIONS

The study focused on two research questions: 1) How do tutors teaching on the course perceive the effectiveness of the Short Course in Speech Listening? 2) What suggestions do they offer to improve the course?

METHODOLOGY

Using questionnaires, a total of 16 tutors who taught on the course; 10 females and 6 males, from the 9 provinces were asked for their views on the following aspects of the course: (1) content, (2) activities, (3) attendance, (4) duration of the course and each class session, (5) availability of resources, and (6) willingness to teach again on the course. The questionnaire consisted of both closed and open-ended questions. Thirteen (13) tutors responded to the questionnaire. This was followed by semi-structured telephone interviews with a sub-sample of 8 tutors representing the 9 provinces.

RESULTS AND DISCUSSION

The tutors' perceptions are analysed according to the questions focused in the questionnaire and the comments by tutors in the semi-structured interviews are also integrated under the discussion of each question.

Perceptions of tutors on the difficulty level of the content of the course book

The first question focused on the perception of the tutors regarding the content of the course book. Table 1 shows that the majority felt that the lessons were just right. A tutor commented; *“most of the lessons were appropriate and the students enjoyed the lessons”*. Three (3) tutors, from Colombo, Kandy and Hatton where the learners had greater exposure to the language, considered the first five lessons as being very easy. These tutors suggested that three lessons (4, 5, and 6) devoted to locations and directions could have been incorporated in a single lesson and other relevant lesson topics added, and more activities for speaking included. The three (3) tutors who considered lessons 6, 7, 8, 9 and 10 as difficult were from the Northern, North Central and Eastern provinces where learners have limited exposure to the English language, unlike their counterparts in the Western and Central provinces.

*Table1: Perceptions on difficulty level of the content of the course book****Perceptions of tutors about the activities contained in the course book***

Tutors' perception of the activities contained in the Course Book shows that here too the majority nine (9) viewed the activities contained in the Course Book as just right and matched the level of students' language proficiency. Two (2) felt the activities were too easy because of repetition of similar processes as well as being predictable. More challenging activities in greater variety for listening and speech were suggested. A comment was made that a guideline to design some activities (with lesson objectives) will be more effective. The two (2) tutors who felt that the activities were difficult, and very difficult were from the Northern and North Central provinces where students were less exposed to the English language than their counterparts in other provinces

Perceptions of tutors about attendance at weekly class sessions

Student attendance at weekly classes indicate: the majority eight (8) reported the weekly attendance at classes was average (50% to 60%), while five (5) stated that attendance was very good (75%). None indicated that attendance was poor. The interview comments revealed that the primary reason for the drop in attendance (25%) was due to students having to attend extra tuition classes on receiving their A/L examination results. Some continued to attend the English classes in preference to classes held to develop soft skills. The good attendance at weekly classes indicates that the students placed high value on the importance of gaining fluency in spoken English.

Perceptions of tutors on the (12 week) duration of the course and each class session

Regarding the duration of the course, the majority (9) indicated that the duration of the course was just right or adequate. However, four (4) tutors were of the view that it was too short because the students felt the need to get more practice, as well as to get help with pronunciation. Suggestions were made to extend the course by three or four weeks for these reasons. Regarding the duration per session, the majority nine (9) were of the view that the five hour duration of each class session was sufficient. However, four (4) felt it was too long, because students were very tired by having to travel long distances in locations such as Vavuniya, Polonnaruwa and Anuradhapura. None indicated that it was too short.

Perceptions of tutors regarding the facilities provided to conduct the course

Tutor perceptions were obtained on four aspects which would impinge on the smooth running of the

LESSON	TITLE	Too Easy	Just Right	Difficult	Very Difficult
1	Making introductions	3	10	-	-
2	Make a Request	3	10	-	-
3	Let us Apologize	3	10	-	-
4	Know your Place	3	9	-	-
5	Finding Places	3	10	-	-
6	Getting there	-	11	2	-
7	Using the Telephone	-	12	1	-
8	At the Bank	-	12	1	-
9	Would you buy them	-	11	2	-
10	Welcome a Guest of Honour	-	12	-	1

course:

The availability of – (i) adequate classroom space, (ii) audio equipment, (iii) photocopying facilities, and stationery for hand-outs.

(i) Availability of adequate classroom facilities

The majority, eight (8), was of the view that the classroom facilities provided at the Study Centres and Regional Centres were good, with adequate space. Four (4) were of the view that facilities were average, for a maximum of 30 students. One (1) tutor indicated that the classroom facilities provided were poor.

(ii) Availability of CD Audio Player

Regarding the availability of CD/audio equipment at the Centers, the majority of eight (8) indicated that CD players were available and in working order, but on some days the player was not available. One tutor reported that power break downs were overcome by students who transferred the recorded dialogues to their mobile phones. Another reported: “*I was never sure about the CD player, so I got my students to go through the listening sections before they came to class, so we had no problem.*” Four (4) indicated that CD players were not available and one (1) indicated that even though a CD player was available it was not in working condition.

(iii) Availability of Photocopying facilities & Stationery

Photocopying facilities were available in all the relative Centres. However, regarding the availability of stationery for hand-outs while eleven (11) indicated that stationery was available, two (2) indicated that it was not available. One tutor obtained photocopies from a nearby service provider. Another suggested that for some activities Bristol board, marker pens and Blue Tack would have been very helpful.

Tutors’ view of willingness to teach on programme again

All thirteen (13) tutors, given the opportunity, said they would be willing to teach on this programme again, because they enjoyed the experience, and it gave them a sense of satisfaction. A reason for their feelings of fulfilment was that they were happy to see students making progress and gaining confidence in speaking English.

Further comments about the course made by Tutors

There were several comments made regarding suggestions for improvement on various aspects of the course. Regarding the content of the course, the following suggestions were made: (1) Include more role-play, drama and songs, (2) include grammar activities into the lessons, (3) make available to tutors, a printed book that can be used in the event of power cuts or malfunctioning audio equipment.

Many suggested the inclusion of a placement test to address the issue of varying proficiency levels. The reasons given were because most students lacked Basic English competency skills, and students need to be of the same proficiency level to reach the desired standard at the end of the course.

One tutor recommended that a follow-up course be conducted to take students to a higher level.

CONCLUSIONS AND RECOMMENDATIONS

The survey results indicate that the majority of Tutors viewed the Short Course in Speech and Listening positively in achieving the objective of enhancing the speaking and listening skills of the learners. A high level of attendance and participation was reported despite a drop in attendance after the release of the A/L results. Noteworthy is that all tutors perceived that all students had indeed gained greater confidence in listening and speaking by the conclusion of the

course. Another positive factor was that all tutors were agreeable to teaching on the programme if it is to be repeated. The non-availability of the desired facilities at some centres did not impinge on the overall success of the course. The variance in views of the difficulty related to lessons and activities is to be expected because the course material was prepared with the objective of assisting O/L students who possessed Basic English language speaking and listening skills. Not all students possessed a similar level of these skills.

It is therefore recommended that the present course design would have to be adapted to also meet the needs of students who are less exposed to English language usage. For students who found the course work very easy, it would be necessary to design a more advanced course that would be different to the course for less advanced students. Furthermore, it appears necessary for the time allocations and activities chosen for the course to be revised and adjusted to meet the needs of students at two levels, which means that two separate courses would have to be held. Additionally, for greater efficiency in teaching as well as for obtaining better results, a placement test before commencement of the course appears to be necessary in order to cater to the varying levels of language proficiency. Feedback from tutors at different centres indicates that there is a need for the OUSL to ensure that all centres are adequately equipped with essential facilities for the course to be conducted in the proper manner. This study focused primarily on tutors' perceptions of the course, and did not investigate students' perceptions and experiences with the course which would be an area for future research which would help to further enhance the quality and effectiveness of the course.

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‘FROM THE EARLIEST TIMES...THERE WERE NEITHER MEN, NOR LIVING BEINGS’: TRADITIONS OF MASCULINITY IN SINHALA AND TAMIL FOLKTALES

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INTRODUCTION:

“Brahmana, for thy assistance thou art to make for thyself a woman.” (*The Making of the Great Earth* – a Sinhala folk tale)

“Why, you are not wanted in this house anymore. You do not deserve to be my wife anymore.” (*The Clay-doll Mother-in-law* -- a Tamil folk tale)

Scholar Michael Roberts (2002) in his research on pre-modern Sinhala society has observed the vast potential of oral forms of communication in the formation of the consciousness of a nation. One such folkloric means is the folktale. Roberts states that, ‘...the vitality of storytelling...provide some measure of the degree to which Sinhalese people have placed emphasis on their culture heroes and past events. ...these were the modalities that enabled Sinhalese as well as Buddhists to become embodied.’ (Roberts: 2002). Roberts issues a clarion call for disciplined analysis of the ideological content of folklore, and this present research (despite its insignificant scope and limitations), in one aspect, is a response to his call.

While acknowledging that there is a dearth of research in Sri Lanka on gender in folklore, this research intends to initiate a debate by analyzing a selected sample of both Sinhala and Tamil folktales from a gendered perspective.

Gendered readings of folklore (particularly in Anglo-American contexts) have revealed that orally transmitted folk tales are more than just mere narrations meant to entertain people. They carry ‘traditions’² (Bronner, 2005) which are gendered and which people inherit. Dundes (2002) and Brandes (1992) in their research position folklore as sites where gender prejudices and assumptions are nurtured and are later driven towards concrete reality in a society.

Feminist studies in women’s folklore (Jordan & Kalcik: 1985; Hollis & Young 1993) suggest that women’s culture emerges from ‘traditions’ shared and maintained by women and that these women’s traditions had their own role in countering the patriarchal traditions that have marginalized and silenced women.

The present research attempts to locate gendered traditions in a selected sample of Sinhala and Tamil folktales – in particular, this research will locate and analyze the traditions of masculinity in the suggested sample.

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² Bronner (2005) quoting two scholars -- Robert Georges and Michael Owen Jones

-- refer to ‘traditions’ in folklore as implying ‘tendencies and continuities through time and space in human knowledge, thought, belief and feeling.’

LITERATURE SURVEY

In the introduction to his folklore research anthology *Manly Traditions: The Folk Roots of American Masculinities* Bronner proposes that ‘the roots of being a man in America are in the traditions men inherit and often adapt for their own purposes in contemporary life.’ (Bronner, 2005: P xi). He goes on to argue that these traditions are ‘critical’ in explaining socially particularized states of masculinities because by nature traditions are ‘vessels for creating meaning, producing metaphors, reinforcing beliefs, and transmitting values through time.’ (Bronner, 2005: pg xii). He also states that folklore is indispensable for the historical, social, psychological and cultural inquiry of a society because it presents the ‘core values’ of a society and also the metaphors by which people live. Gender in folklore he states, serves the purpose of making the ‘unconscious or unselfconscious, conscious.’¹ He goes on to posit folklore as a site where one could locate ‘unrivalled evidence of gendered behavior due to the ‘symbolic communication it encapsulates, the potential for structural, situational and comparative analysis it suggests...the values, metaphors and beliefs it embodies.’ (Bronner 2005: 04).

In a survey of American folklore texts folklorist Alan Dundes² hypothesized that the American culture exhibits a “male bias,” even “male chauvinism.” Dundes argues that the biases, prejudices, beliefs, and values found in the texts are actively transmitted through time and space, often ‘unconsciously or unselfconsciously,’ through folkloric means.

Brandes (1992) in his comprehensive research on masculinity of Andalusian folk tales argues that folklore essentially reflects assumptions about masculinity and gives such assumptions a concrete reality. ‘They show men who they are and what they should be.’ (Brandes 1992: 07). In addition, Brandes (1992) argues that folklore provides a culturally acceptable outlet to males for expressing frustrations, tensions, feelings that cannot be expressed directly. He says that men also use folklore to express and maximize their power hierarchies.

METHODOLOGY

This research will entail re-reading 25 Sinhala village folk tales and 25 Tamil Folk Tales from a masculine perspective. To analyze masculinity in a given narrative space this research will:

- ❖ Locate and interpret the ‘traditions’ of being a male as depicted in the stories. As suggested by Bronner this study will assume the folkloric implications of ‘tradition’ as ‘tendencies and continuities through time and space in human knowledge, thought, belief and feeling.’ Folklore researchers assume that ‘tradition’ carries connotations of cultural authority and hence tradition tends to form patterns that can be identified, compared and interpreted. This research will thus identify, compare and interpret those ‘patterns’ of tradition as well as the meanings, values and metaphors created by them.
- ❖ scrutinize the power hierarchies created between males in the texts
- ❖ locate the ‘traditions’ associated with females in the narrations in order to initiate an inquiry as to how the masculine ‘traditions’ are shaped by the ‘traditions’ of females.³

¹ Bronner borrows those terms from the folklore scholar Alan Dundes who wrote the afterward for his book *Manly Traditions: The Folk Roots of American Masculinities*

² Dundes’s work is extensively quoted in the Bronner’s folklore anthology *Manly Traditions: The Folk Roots of American Masculinities*

³ Folklorist Bronner (2005) proposes that ‘traditions’ men know are those they communicate to one another in their social interactions and are shaped by what women do and such traditions are often inherited from



RESULTS AND DISCUSSION

The masculine traditions identified in the narrations are similar in both the Sinhala and Tamil folktales. The 'male' is defined in a power dyad as a superior entity against the inferiority of the female. Labor is defined according to gender with the 'male' involved in tasks that are dynamic vs the female who is engaged in static tasks. Desire is male driven and follows the heterosexual normativity. However, the traditions of being a male in the texts promote a particular kind of 'maleness' which is valorized, thus creating a power struggle among males. At the same time, there are females who perform 'male' attributes to perfection and the narrative plots usually neutralize that power in the end. This research will engage in a lengthy discussion on the last two points.

CONCLUSIONS AND RECOMMENDATIONS

The traditions of being a man in these tales suggest both a power dyad in gender as well as a vulnerable masculinity which can be undermined by other masculinities. These male vulnerabilities could be a research area that needs further attention. This study uses only a limited sample due to time as well as a means of testing the ground for a lengthy research based on a larger sample.

LIMITATIONS

Translation, according to Lawrence Venuti, is not a 'simple communicative act' but a 'domestication of a foreign text.' This research acknowledges that there could have been problematic issues in the act of 'transliteration' by the translators of the both volumes of folk tales despite their best intentions.

This research does not attempt to discover masculinity as a subjective or lived experience. Rather it analyses cultural ideas, symbols and narratives that could have evolved as a consequence of a male subjectivity.

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CAN THE EFFICIENCY OF L2 SUMMARIZATION BE IMPROVED: COSTS AND BENEFITS

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INTRODUCTION

In a summarizing task it is essential to convey correct information effectively as well as efficiently in a condensed form. Therefore, summary writers should have an adequate language ability to read, comprehend and reproduce information in a condensed form, whether the summary is produced in the first language or in the second language. Thus, quality of the summary is an important phenomenon as it reflects how effectively and efficiently information is reproduced. In Garner's (1982) study that assessed "efficiency of summarization" she claims that high-efficient students store information in memory efficiently while processing the information efficiently.

Most of the research conducted on summarization is based on the model of text comprehension developed by Kintsch and van Dijk (1978), and modified later by Brown and Day (1983). This model provides a theoretical explanation of how summarizing information promotes deep comprehension and learning. Further this theory explains how summary writers have to select the important ideas from the text, while reconstructing the meaning in a more succinct and general manner. Summary writing plays an imperative role not only in the reading and writing processes, but in the learning process as well, since, through summarizing a text or a passage students can judge the level of comprehension and retention of information that they have gathered (Bharuthram, 2006).

The current study examines the summary writing performance of thirty six Sri Lankan upper intermediate English as a second language (ESL) university students with special reference to the quality of their summaries before and after they were provided instruction on summary writing. The objective of this study is to examine the efficiency of summarization of upper intermediate level university ESL students and the impact of instruction on the quality of summary in their summary writing performance.

METHODOLOGY

The following two major research questions are addressed in this study:

- What is the level of quality of the summary of upper intermediate ESL students?
- To what extent does instruction affect efficiency of L2 summarization?

The hypotheses formulated were based on one general hypothesis: 'There is no significant difference between the means for the pre-test and the post-test groups'. Further, this research is concerned with null hypotheses and other possible outcomes in the form of alternative hypotheses. The sample consisted of 36 first year Diploma in English students from the Open University of Sri Lanka. These students learn English as a second language and their English proficiency level is at upper intermediate level. The participants completed a pre-test summary task before they were taught summary writing. This was followed by a post-test summary using the same source text after providing summarizing instruction. The pre-and post-test summaries were analyzed in terms of the quality of the summaries.

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The method used by Palmer and Uso (1998) and Garner (1982) was adapted in the process of measuring the quality of the summaries. The following calculations were done in order to measure the quality of the summaries.

- students' inclusion of main points and the number of words used in students' summaries
- total number of main ideas and the average of main ideas per summary
- total number of words and the average of words per summary
- average of main ideas per summary was divided by the average of words per summary

Quality of the summaries of pre-test, as well as post-test, was calculated separately. However, grammar mistakes and text elaboration were disregarded at this point (Palmer & Uso, 1998). In addition to the textual analysis of the summaries, the impact of instruction on efficiency of summarization was also examined by comparing the quality of the summaries of the pre-and post-test summaries. The data obtained were scrutinized quantitatively. *T test* was applied as the main technique in the inferential statistics analysis while utilizing the Statistical Package for Social Sciences (SPSS) for the data processing. *Paired t-test* was applied to obtain *paired samples statistics* and *paired samples test*. Under *paired samples statistics*, value of *mean*; *standard deviation*; and *standard error mean* of the pre-test and the post-test were examined while *paired samples test* evaluated the *paired differences*. The outcome of *t test* was utilized to compare the *p-value* with the selected value of the *significance level*.

RESULTS AND DISCUSSION

1) What is the level of quality of the summary of upper intermediate ESL students?

In order to test the quality of the summary, first, the number of main points presented in each summary was counted, while calculating the number of words presented in each summary. Next, the total number of main points and total number of words included were calculated. Subsequently, the average of main ideas per summary and the average of words per summary were computed. Finally, the average of main ideas per summary was divided by the average of words per summary to obtain the level of quality of the summary (Palmer and Uso 1998; Garner, 1982).

The calculation of main points and number of words used in the pre-and post-test are demonstrated in the following table.

Table 1: Number of Main Points and Words Used in the Pre and Post-test Summaries

	Pre-test	Post-test
Total number of main ideas	116	156
Average of main ideas per summary	3.22	4.33
Total number of words	2475	2337
Average number of words per summary	68.75	64.91
Level of quality (Main ideas/words)	0.046	0.066

According to table 1 it is observed that the students had identified at least 3 main points out of 6 main points, while using approximately 69 words as an average number of words in the pre-test summary, resulting in the level of quality of pre-test summary being 0.046. Further it can be predicted that in the post-test summaries students had employed at least 4 main points as an average, while utilizing approximately 65 words as an average number of words, as creating the level of quality of post-test summary being 0.066.

2) To what extent does instruction affect efficiency of L2 summarization?

Under this question it was examined whether students had improved the efficiency of summarization after they were provided the summarizing instruction. In order to examine the improvement of quality of the summary, the main ideas and the number of words included in the pre-and post-test were compared.

Main Hypotheses:

H₀ - There is no significant difference between the means for the quality of summary in the pre-and post-test groups.

H₁ - The mean for the quality of summary in the post-test group is significantly higher than that for the pre-test group.

Sub Hypotheses I:

H₀ - There is no significant difference between the means for the number of main points included in the pre-and post-test groups.

H₁ - The mean for the number of main points included in the post-test group is significantly higher than that for the pre-test group.

Sub Hypotheses II:

H₀ - There is no significant difference between the means for the number of words included in the pre-and post-test groups.

H₁ - The mean for the number of words included in the post-test group is significantly lesser than that for the pre-test group.

Clustered bar figure in figure 1 demonstrates the percentages of the frequencies of number of main points included by the students in the pre-and post-test summaries.

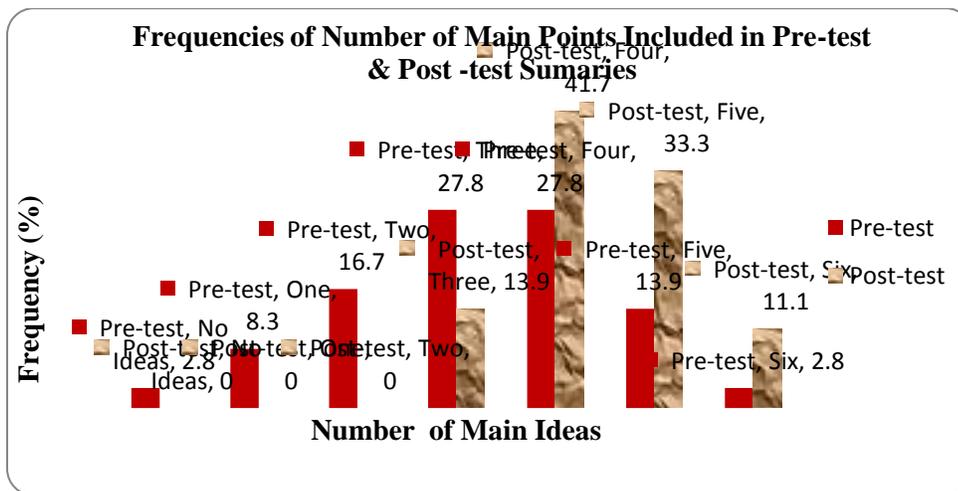


Figure 1: Frequencies of Number of Main Points Used in the Pre-and Post-test Summaries

As figure 1 presents, more number of main points were identified in the post-test than in the pre-test. That is, four, five, and six main ideas were included in varying degrees: 41.7%, 33.3%, and 11.1% respectively in the post-test summaries whereas ‘no ideas’, ‘one’, and ‘two’ main idea

categories are represented only by the pre-test. Thus, it is obvious that more number of main points were included in the post-test summaries than in the pre-test.

Next, results of the paired samples test of number of main ideas, as well as number of words included in the pre-and post-test summaries are discussed.

Table 2: Paired Samples Statistics of Main Ideas and Number of words Included in the Pre-and Post-test Summaries

	Mean			N	Std. Deviation		Std. Error Mean	
	Main Ideas	No. of Words	Level of Quality		Main Ideas	No. of Words	Main Ideas	No. of Words
Pre-test	3.22	68.75	0.047	36	1.355	7.883	.226	1.314
Post-test	4.42	64.78	0.068	36	.874	5.688	.146	.948

According to table 2, the post-test obtained higher mean (4.42) for the inclusion of the main ideas than the pre-test (3.22) by improving the inclusion of main ideas in the post-test. Meantime, the mean of the number of words employed in the post-test summaries (64.78) is lower than in the pre-test (68.75) by indicating that the students had utilized lesser number of words in the post-test than in their pre-test summaries.

Table 3 shows the paired differences of the main points included and the number of words used in the pre-and post-test summaries.

Table 3: Paired Samples Test of Number of Main Ideas and Number of Words Used in the Pre-and Post-test Summaries

		Main Ideas	No. of Words
Paired Differences	Mean	-1.194	3.972
	Std. Deviation	1.261	9.620
	Std. Error Mean	.210	1.603
	95% Confidence Interval of the Difference	.717	.717
	Upper	7.227	7.227
T		-5.684	2.478
Df		35	35
Sig. (2-tailed)		.000	.018

Considering the *p value* or the significant level for the main ideas in the table 3, it can be decided that the null hypothesis (H_0) of sub hypothesis I is rejected since the *p value* is $.000 < .05$ (α).

Further as it demonstrates the *p* value for the number of words used is $.018 < .05$ (α) the null hypothesis (H_0) of sub hypothesis II is also can be rejected.

As a final point, by scrutinizing the means for level of quality, we can conclude that the post-test has obtained a higher mean (0.068) than the pre-test mean (0.047). Thus, the null hypothesis (H_0) of the main hypothesis can be rejected while accepting the alternative hypothesis (H_1).

CONCLUSIONS

Considering the overall findings, the pre-test summaries as well as post-test summaries can be considered as "middle-range efficiency summaries" as Garner (1982:277) defined "middle-range efficiency summaries would present some of the important ideas in a moderate number of words" in the concept of "efficiency of summarization". However, an improvement could be noticed in the level of quality of the post-test since the average of the main points included was increased from 3.22 to 4.33, as well as the average of number of words employed was reduced from 68.75 to 64.91. Accordingly, these data provide evidence that, after students were provided instruction on summarization they were able to depict a high number of relevant points in a fairly moderate number of words in their post-test summaries. Thus, the number of words and the main points included in a summary can be considered as the cost while the quality of summary is the benefit. Consequently, the posttest summaries yielded better cost/benefit results by improving the quality of summaries. Although all the students had not fully developed their skills to identify all main points that were included in the source text even in their post-test summaries, they may need more practice in summary writing to fully improve their efficiency of summarization. Although the current study considered only quantitative data obtained from the performance of the pre-and post-test summaries, qualitative data of the study would have provided an extensive view on summary performance as summarization procedure involves many more complex processes.

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DEMONS AND RELIGION, CHAOS BACK HOME: AN EXPLORATION OF “IF THE MOON SMILED” AS AN EXPATRIATE NOVEL.

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INTRODUCTION

Chandani Lokugé’s “If the Moon Smiled” has already established itself as a work of expatriation by a migrant Sri Lankan writer, since its publication in 2000. Following the wake of many other migrant writers who draw upon their culture of origin in order to create, Lokugé too devotes a considerable section of her novel to scenes set in the ‘homeland’, in her case, scenes of Sri Lankan village life. While her powers of description of the scenic Sri Lankan village are laudable, she has been often susceptible to charges of essentialism and orientalism. As this aspect of her writing is fairly well-known, I would like to specifically dwell on the battle between sensuality and religious impulses which features as the primary personal conflict (with regard to the protagonist Manthri, and to a certain extent, also to other expatriate figures) in the novel.

The protagonist is shown to be a woman brought up on a diet of Sinhala Buddhist traditional values. She is constantly portrayed as a woman caught in painful division between the cultural restrictions and inhibitions around her and her own impulsive sensuality. The failure to reach a compromise between these two divergent values is shown to constitute a case for expatriation, while the author insinuates paradoxically that this division is also the reason why Manthri and her family cannot ‘flourish’ as expatriates and come to terms with their identity. Her environment is seen to be awash with allusions to this duality or conflict, as shown by Chandani Lokugé when she writes, ‘The futility of their (the villagers intent upon their religious activities) search for detachment in a world that passionately demanded and offered attachment’. (Lokugé, 2000)

This fundamental division or conflict is shown to have arisen from the villagers’ association with Buddhist values and their accompanying ideology of impermanence and renunciation. Lokugé attempts to depict Buddhism as an integral part of Sri Lankan life, and her mode of narration and her almost documentary reportage of Buddhist customs create an exotic effect which would register well with a foreign readership. The notion that Sri Lankan villagers are governed by an all-encompassing, alien (to the international reader) set of religious values would undoubtedly appeal to a readership in quest of exotica. The result is a picture of a village which invokes a timeless or archetypal ‘feel’ inhabited by stock characters such as the patriarchal, traditional father, the devout and sober mother and the faithful crone. It becomes very tempting to link the village Chandani Lokugé creates with the idea of the orient that Edward Said expounds in his work “Orientalism”. Said writes, “The Orient that appears in orientalism is a system of representations framed by a whole set of forces that brought the orient in to the western Consciousness.” (Said, 1978)

METHODOLOGY

Within this paradigm I would like to explore how the author’s portrayal of her protagonist as a woman caught between the detachment preached by Buddhism and her own joie de vivre and sexual energy is constructed.

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I hope to inquire in to how she achieves this by juxtaposing sacred or religious imagery with imagery associated with desire and sexuality in the novel. For instance, flowers which are traditionally linked with Buddhism and the east are cast in a different light when Lokugé invests them with sensuality. This is rendered with considerable attention to artistic detail when Lokugé writes, “She pauses often to caress her face with the white-gold petals, and feels them delicate against her skin [...] She breaks off a blossom and breathes it. She brushes her lips on purplish – blue petal.” (Lokugé, 2000)

The over-arching Buddhist ideology that Lokugé wishes to depict, as the chief governing force behind the villagers’ lives (as depicted chiefly through the cautionary statements of a religious nature by certain characters) would be scrutinized. I intend to analyze some of the figures of the novel who belong to the serving class in order to study their links with pagan or ‘indigenous’ forces. I would like to dwell upon the significance of these pagan, ‘unrestrained’ values in an expatriate work.

RESULTS AND DISCUSSION

In Lokugé’s “If the Moon Smiled” Buddhism has been invested with unnecessary rigidity in order to demonstrate this split and its effect on Manthri’s psychology. Lokugé peppers the text with incessant references to Buddhism and the impermanence of life to prove her point. Characters are seen to draw Buddhism in to all aspects of their lives and this produces a somewhat strained effect. Lokugé writes,

“Look at the creepers, entangling everything like lustful cravings!” and “(The lanterns) might go up in flames. And if they did, my father would say: ‘Did you see that, *duwa*? That is the impermanence of life. All is transitory” (Lokugé, 2000)

The values projected through these figures are perhaps too rigid to be identified with Buddhism’s hold on lay men and women. It is true that Buddhism has always had an integral part in Sinhala Buddhist village life, but to claim that it was so to the exclusion of all the other aspects of life is surely taking it too far. As it is widely known, Buddhism does not require lay men and women to restrain their sexuality or to constantly dwell on the impermanence of life. A Buddhist monk or nun may feel this conflict but hardly a lay woman.

A significant feature of her novel is that she does not extend this constant aversion that she claims traditional Sinhala Buddhists feel towards attachment and desire to the members of the serving class. They are shown to represent an intuitive, wild almost ‘pagan’ aspect of life. Figures such as Thilakasiri, Karuna and even Dingiri whom Lokugé attempts to depict as characters untouched by ‘progress’ are always associated with nature and ‘indigenous life’. They are uninhibited and open about sexuality and see fertility and reproduction as part of their day to day existence. A case in point would be the following exchange between Manthri, Manthri’s mother and Dingiri. Lokugé writes, “ ‘yes,’ Dingiri chuckles noisily. ‘We will work *before* the wedding. *After* the wedding it will be Manthri *menike* who will bear the burden’. The mother chooses not to understand the insinuation. Sometimes Dingiri forgot she was only a servant.’ ” (Lokugé, 2000)

The servants (all of them again stereotypes, the gallant rogue, the saucy maid whom he assumedly seduces, and the old, faithful nanny) are invested with ‘natural’ life, and associated with an older, more primordial reality than the one Manthri inhabits. Although they are undoubtedly Buddhists they are often linked to demonic or ‘pagan’ forces. Lokugé writes, “The phantom rips free and rushes with streaming hair towards the river [. . .] Thilakasiri’s voice hovers over her.” (Lokugé, 2000)

It would be interesting to inquire as to how a portrayal of this kind would fit in with the writer's agenda as an expatriate author. The depiction of natural, possibly pre-colonial, pre-civilization forces which lurk beneath an apparently placid front, threatening to surface is reminiscent of the writing of another celebrated expatriate writer, Romesh Gunasekera. In "Reef", summoning the compelling image of demons and devils in a suggestively 'uncivilized jungle' Gunasekera creates an aura of pagan violence and barbarity held at bay beneath a very thin veneer of civilization. Gunasekera writes, "(The tank created) a perfect peace that seemed eternal even though the jungle might unleash its fury at any moment." (Gunasekera, 1994) In fact, in his analysis of Reef in "Images of Sri Lanka through Expatriate Eyes: Romesh Gunasekera's *Reef*" Walter Perera dwells on the sub-human, pagan and demonic characteristics attributed to almost all of the members of the novel's working class which again strikes a chord with Lokugé's "If the Moon Smiled". Perera writes, "Indeed, except for the cook, [. . .] none of the members of Triton's own class (i.e., the serving class) are regarded with much favour. His uncle's "speech . . . was a strangulation of the spirit" (p.17), and the haberdasher, like Joseph, is described in animalistic language" (Perera, 1995). Joseph, the senior servant at Mr. Salgado's, who is supposed to have a "head shaped like a devil-mask", is described in terms that are unmistakably demonic. (Gunasekera, 1994)

CONCLUSIONS AND RECOMMENDATIONS

Demons and devils and 'indigenous' phantoms which occur as a recurring motif in both these novels have a purpose beyond the obvious one of appealing to the exotica-seeking minds. They, along with their accompanying culture of violence, irrationality and unpredictability are shown to represent the 'real nature' of Sri Lanka and its inhabitants. They are shown to be linked to a force which resists and defies civilization. In short, they subscribe very well to the ideology of the Orient as violent and untamed. As Perera puts it, with regard to "Reef" "The savagery of the present is only a natural descent from the 'barbarity' of the past." (Perera, 1995) This pattern is visible in "If the Moon Smiled" where Manthri is seen to succumb to primordial, wild and 'untamed' forces. We could perhaps link what the renowned postcolonial critic Elleke Boehmer says about Graham Greene's depiction of "*native*" Mexico to further illustrate this point. Boehmer writes, "Greene adopts wholesale Lawrentian evocations of native Mexican life as a 'cruel anarchy' and a recurring cycle of violence." (Boehmer, (2005)

Likewise, the transformation of Buddhism in to a religion which imposes numerous taboos and restrictions upon the Sri Lankan villagers by the writer promotes the essentialist picture of the Orient that Lokugé clearly tries to project. Her attempts to manifest the effect of the native culture on Manthri in Australia also further this image and She is constantly associated with Buddhist Jathka stories, traditional Sri Lankan art, etc.

The fact that it's the child Manthri who experiences the idyllic rural past the adult Manthri is trying to invoke gives fresh insight in to Lokugé's work as an expatriate work. On one hand Manthri can be linked to the kind of expatriate, who in Salman Rushdie's words "looks back" at the homeland. Although return, or rather a permanent return is never possible for this kind of expatriate, she still looks back, as in Rushdie's metaphor, perhaps through a "broken mirror" (Rushdie, 1991). Given the shift in space and time she has experienced as an expatriate, it is possible that her memories acquire a special significance because of that distance. It is equally possible that the idealization of the village as well as the intensity of her feelings for Thilakasiri is a result of "looking back" from a distance. The views Rushdie brings forth in "Imaginary Homelands" is worth looking at in this respect; Rushdie claims, "It was precisely the partial nature of these memories, their fragmentation, that made them so evocative [...] the shards of memory acquired greater status, greater resonance, because they were *remains*; fragmentation

made trivial things seem like symbols, and the mundane acquired numinous qualities” (Rushdie, 1991).

The angst or despair caused to Manthri as she ‘looks back’ at the homeland left behind may have also contributed to the lack of clarity and coherence she demonstrates as a narrator.

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COMMERCIAL MANNED SPACE TRANSPORTATION: AEROSPACE LAW'S LATEST CHALLENGE

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INTRODUCTION

Commercial manned space transportation is about to be launched on a larger scale. One important development of commercial manned space transportation is space tourism (also known as space travel, space flights, suborbital flights etc.). Space tourism was started by MirCorp in Russia in the 1990s. Denis Tito, a US millionaire became the first space tourist, followed by Mark Shuttleworth, another South African millionaire to travel into space with the Russians. However, when the Russian Space Agency decided that the Soyuz capsule could only transport the crew to and from the International Space Station, taking 'tourists' to space was suspended temporarily. There are a few interested groups which try to compete in the space business with Sir Richard Branson's successfully launched Virgin Galactic mission, Blue Origin, Armadillo Aerospace and XCOR Aerospace taking the lead. A debate has started as to how to regulate the growing aerospace business. There are separate international legal regimes for air law and space law. But commercial manned space flights do not necessarily fall into either of the two regimes though they carry characteristics of both, plus several unique features that need to be freshly looked into. Sovereignty and liability issues need to be particularly addressed as space journeys cross national airspace, travel through outer space and return to national airspace travelling through the sovereign airspaces of many states. The objectives of this research include (a) investigating the characteristics of commercial manned space flights (passenger), (b) analyzing the current international laws applicable to aerospace travel and the gaps that need to be answered (c) finding out the existing governmental preparedness to regulate the aerospace business and the challenges ahead and (d) suggesting what should be legally done to prepare the launching and development of the commercial space business.

METHODOLOGY

The proposed study is a normative research and thus based on literature. The data collection for this research is done from both primary and secondary sources. The primary data collection would include an in depth study on the current legal instruments, international Conventions which address the status of the aircraft, space objects and the rules governing respective modes of navigation, ICAO related documents and working papers, the reports and working papers of the United Nations Committee on Peaceful Uses of Outer Space (UNCOPOUS). Further, arrangements made by individual states namely, the USA, Russia, Japan and the EU are analyzed. Works of the International Law Commission (ILC) are considered to understand state responsibility towards aerospace navigation. The secondary means of data collection is aimed to be achieved by research works and articles on the subject.

RESULTS AND DISCUSSION

Commercial manned space flights intend to take interested people into outer space for payment. However, the risks involved in space flight warrant a proper legal and regulatory framework both nationally and internationally. The main issues to be addressed in the wake of commercial

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manned space transportation are the proper forum to regulate commercial space travel, status of the 'vehicle' to be used, the liability of the vehicle operators, the extent of governmental presence in the business as mostly space travel to be privately owned and operated depending on the high operational costs involved and the impact on the climate. Apart from these issues, human and health factors play a big part in suborbital flights. Can commercial manned space activities be developed as a major tourist activity with all these issues? This has been the major concern over the years.

Who would be the international regulator for the emerging industry? The necessity for a new regime for the commercial space industry has been in the focus for a considerable time now. Scholars cater for a new regime which outlines the basic legal principles, as in the case of aviation, because of the apparent failure of existing international and national space law to specifically address the issues of space tourism. Further, new international legal regimes are hard to come by and the time taken to amend the existing laws will not be tolerated by the industry, which is keen to get things going. The legal subcommittee of the UNCOPOUS had been the principle lawmaker for space law. However the International Civil Aviation Organization (ICAO) seems to be the proper authority as space travel has more or less similar principles to aviation. Space journeys obviously cross the air space of many countries and overlap with the underlying principles such as sovereignty over air space. Therefore ICAO could be the ideal forum for the development of laws for the industry. The involvement of ICAO would be to harmonize the two regimes and to draft documents dealing with the responsibility of states in space tourism, the safety and security matters, liability issues and other important areas. But the ICAO is not mandated by the Chicago Convention (1944) to regulate space activities. Therefore ICAO should be given the necessary mandate to deal with aerospace travel.

At the time the international space law system was developed by the UNCOPOUS, there were no signs of any transportation of people into outer space for reward. Therefore none of the international treaties on the moon and outer space carry provisions relating to the liability of service providers in space tourism. However, since the provisions embodied in space law treaties are broader in scope, some relevance could be drawn from these legal provisions. For instance, Article 1 of the Outer Space Treaty (1967) states that outer space is free for exploration and use by all states and guarantees the free access to all areas of celestial bodies. This broad provision carries general permission to any person to travel in space. Even though the provision does not specifically cater for the 'commercial' nature of space activities, space tourism could be categorized under 'use' of outer space. Likewise the Rescue and Return Convention (1968) confers responsibility on the state in whose territory the space object lands in cases of accident or unintended landing, to inform the launching authority (Article 6) which is responsible for the particular launch about the incident, as well as the Secretary – General of the United Nations (Article 3). The major problem with all the international treaties and conventions concerning outer space is that they recognize 'astronauts' only and ordinary people are not accounted for. Thus the current space law treaty system is inadequate to cover commercial manned space travel.

The 'vehicle' to be used is obviously a hybrid vehicle which could travel through both airspace and outer space. The vehicle operates as an aircraft for the first stage of the trip, but for the other two steps the vehicle becomes a space object which operates on rocket-mode propulsion. Thus the vehicle itself attracts the regimes of both air law and space law. The issue of registration comes next as the vehicle should be registered as two parts according to its classification. This practice would lead to confusion, as registration of space objects under the Convention on Registration of Launched Objects into Outer Space (1974) is flexible as to where to register (the state). In contrast Article 17 of the Chicago Convention mandatorily requires the registration of the aircraft with a particular state in order to obtain nationality.

Regarding liability, air law has a comprehensive liability law system from the Warsaw regime (1929) through the Montreal regime of 1999. But Article II of the Liability Convention (space law) makes the launching state absolutely liable for damages caused by its space object on the surface of the earth, and to aircraft in flight. The liability is based on the fault principle if the damage is caused 'elsewhere than on the surface of the earth.' Thus harmonization of the two regimes is required to avoid further confusion.

Government presence in commercial space travel is limited to 'regulation,' depending on the cost, and private sector participation is encouraged to carry out the business. On the regulatory side the USA has taken the initiative to regulate the up and coming industry, the success of which would set a model for other states in regulating their respective markets. This is a result of the implementation of the U.S. Space Exploration Policy, dated January 14, 2004. In 2005, the Office of Commercial Space Transportation of FAA published two sets of draft guidelines for 'Commercial Suborbital Reusable Launch Vehicle Operations with Flight Crew' and 'Commercial Suborbital Reusable Launch Vehicle Operations with Space Flight Participants.' These guidelines are drafted to initiate a regulatory framework, which facilitates the development and safety of human commercial space flights. Even though the Russians have already initiated carrying paid tourists into outer space, they are yet to come up with a regulatory framework for their industry. Japan has shown a clear interest in space tourism and plans its first flight into space with tourists in 2017. The Commercial Space Activities Legislation Research Committee of the Japanese Rocket Society together with the Transportation Research Committee and Space Travel Commercialization Research Committee are working on commercialization of space activities, the design of a Japanese spaceship 'Kankoh-maru', its development and costs, and the spaceworthiness of commercial spaceships.

Carbon emissions have become the most challenging threat to commercial space activities. Environmental circles have started assessing the environmental damage caused by space tourism operations and call for appropriate actions, otherwise there is a risk of environmentalists taking direct actions to stop operations!!

Thus the commercial space activities looks a lucrative business open for the 'rich' but the challenges attached to the business have made it a 'high risk' adventure on all fronts.

CONCLUSIONS/RECOMMENDATIONS

Flying is inherently risky. Flying through the outer space is even more risky. It is reflected that the risk attached to commercial space activities are enormous as there is no proper international regulatory basis addressing the crucial issues of commercial space flights. Though the current international space law system does address commercial space activities in a broader sense, there should be a new international system to cover the commercial aspects of space activities exclusively. To this end the current international aviation and space regulators should be given necessary mandates to draft a mechanism to provide the background for commercial space providers. Such a mechanism should include licensing procedures, registration and liability issues and a system to minimize environmental hazards. On individual basis, the states should draft proper legislation and regulatory systems to keep a proper record of commercial space activities carried out by operators registered in their respective states.

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**PRESUMPTION OF INNOCENCE AS AN EFFECTIVE PROTECTION TO ENSURE
THE RIGHTS OF SUSPECTS WITHIN THE CRIMINAL PROCEDURE SYSTEM:
SPECIAL REFERENCE TO SRI LANKAN AND GLOBAL TRENDS.**

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INTRODUCTION

The presumption of innocence is an ancient principle which can be traced beyond English Law, the ancient Roman Empire and Greek civilization to Deuteronomy². According to this principle suspects are considered innocent until their guilt is proved. In the case of *Coffin v. United States*³, the United States Supreme Court held that, ‘the principle that there is a presumption of innocence in favor of the suspect is the undoubted law, axiomatic and elementary, and its enforcement lies at the foundation of the administration of our criminal law.’ The application of the presumption is not limited to the confines of the courtroom. Its application begins from the moment that a person is investigated⁴.

In order to apply the presumption of innocence effectively, it is of the utmost importance to adopt globally recognized standards and norms into the criminal procedure system. The presumption of innocence implies several rights of suspects including the right to be silent, and the right to be free from torture. Particular emphasis has been placed on the presumption of innocence as a fundamental principle of criminal justice by the courts of Sri Lanka.⁵ In the case of *R v. Sumanasena*,⁶ Chief Justice Basnayeke stated that; ‘suspicious circumstances does not establish guilt nor does the proof of any number of suspicious circumstances relieve the prosecution of its burden of proving the case against the suspect beyond the reasonable doubt and compel the suspect to give or call evidence’. The presumption of innocence has been accepted globally in order to protect the rights of suspects. The International Covenant on Civil and Political Rights (ICCPR) declares that ‘Everyone charged with a criminal offence shall have the right to be presumed innocent until proven guilty according to law’⁷. This presumption is enshrined not only in the ICCPR, but also in many international and regional instruments, such as the Universal Declaration of Human Rights⁸, the American Declaration of the Rights and Duties of Man⁹, the American Convention on Human Rights¹⁰, the African Charter on Human and People’s Rights¹¹,

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² *Coffin v. United States*, 156. U.S. 432; 15.S.Ct

³ *ibid*

⁴ De Silva. S., LST Review, April/ May, 2008

⁵ Peiris G.L., P.116

⁶ (1963) 66 NLR 350, at. p.351

⁷ Article 14, clause 2

⁸ Article 11

⁹ Article XXVI

¹⁰ Article 8(2)

¹¹ Article 7(b)

and the Arab Charter on Human Rights¹. It is also found in the United Nations Standard Minimum Rules for the Treatment of Prisoners.²

This study seeks to ascertain the way in which the presumption of innocence is violated (affecting suspects thereby) in the criminal procedure process by police officers in Sri Lanka. It will also suggest improvements to the laws relating to this area in order to use this presumption as an effective mechanism to minimize these types of violations, in turn protecting the rights of suspects.

MATERIALS AND METHODOLOGY

The research is mainly based on the literature review in the areas of Law of Criminal Procedure and Human Rights law. In Sri Lanka, the research is based on statutes, including the Code of Criminal Procedure Act No.15 of 1979 and the 1978 Sri Lankan Constitution, academic expressions, judicial officers' opinions and recent judicial decisions. This study also considers the principle of international human rights in this regard.

RESULTS AND DISCUSSION

As described previously the presumption of innocence is a crucial principle which serves to protect the rights of suspects within the criminal procedure system. I identified three ways by which this presumption of innocence can be protected. Firstly, according to the United Nations Human Rights Committee, the presumption is breached where public officials prejudge the outcome of a trial.³ The term 'public officials' include judges, prosecutors, the police and government officials, all of whom must avoid making public statements of the guilt of an individual prior to a conviction or after an acquittal⁴. In case of *Worm v. Austria*⁵ this idea was strongly discussed in protecting this presumption.

Secondly, protecting the presumption of innocence relates to the burden of proof.⁶ The burden of proof refers to which party will have the burden of proving a particular fact or set of facts. In order to uphold the presumption of innocence, the burden of proof should be on the prosecution to prove the guilt of the accused rather than on the accused to prove his or her innocence.⁷

The third way in which this presumption can be maintained relates to how the suspect is being presented.⁸ A suspect person should not be made to look like a guilty person by being caged or shackled in the court room. If possible, the suspect should be allowed to remain as a member of the general public for the duration of the trial. However, this rule will not be violated where the suspect person needs to be handcuffed to prevent his escape or to maintain the general security of the court room.

The presumption of innocence necessarily involves the notion of the superior probability of innocence as opposed to the superior probability of guilt.⁹ Yet, when it comes to investigations in Sri Lanka, the dominant principle appears to be that of a superior probability of guilt.¹⁰ Consequently, ignorance or disregard of the presumption of innocence in the criminal procedure

¹Article 16

²Rule 84(2)

³United Nations Human Rights Committee, General Comment no.13 paragraph 7

⁴<http://www.usip.org/files/MC2/MC2-7-Ch4.pdf>

⁵European Court of Human Rights, App. No.83/1996/702/894, August,29,1997, Para 52

⁶*Rangasamy v. Pakeer* (1991)14 NLR 190, *R v. Batcho*(1955) 57 NLR 100

⁷*R v. Sumanasena* (1963) 66 NLR 350 at. P.351

⁸<http://www.usip.org/files/MC2/MC2-7-Ch4.pdf>

⁹Dissanayake.D, LST Review,271 (May 2010), p.17

¹⁰De Silva. S., LST Review, April/ May, 2008

system will result in a large number of incidents of torture of suspects in police custody, fabrication of evidence and cases in order to obtain convictions, insertion of false entries into record books, forcing suspects to confess on fabricated cases etc. There have been instances where police officers compel suspects to confess to a crime which the person knew nothing about. Examples of such cases are the case of *Gerald Mervin Perera*¹, where the suspect was arrested due to mistaken identity and was tortured in order to confess about a murder. The case of the *Angulana Dual Murder, murder of Balavarnam Siva Kumar in the Bambalapitiya Sea* by a police officer, and the case of *Nipuna Ramanayaka*, who is a student of SLITT and who was tortured by police officers in custody are important examples of the current trends.

As discussed previously there are three ways of protecting an accused person's right to the presumption of innocence and these standards are also recognized globally. However, in Sri Lanka this right is not upheld and a large proportion of suspects are not treated as innocent while in police custody. This is apparent from the cases discussed above. Further, some provisions of the Code of Criminal Procedure (hereinafter CCP) also impliedly assist police officers such violations; such as section 110 (2) of the CCP. According to this provision suspects are bound to answer all questions which are asked by the police officers in relation to a crime. Often police officers misuse this provision and torture the suspects to obtain answers. Such practices clearly violate the principle of the presumption of innocence as it is clear that the right to be silent is an aspect of this presumption as can be seen from the globally recognized *Miranda Warnings*.² But in Sri Lanka these are not recognized, nevertheless *Miranda Rights* are of the utmost importance to establish justice in this process of criminal procedure.

CONCLUSION

The law has a significant role to play in striking a balance between the rights of the society and rights of the individual suspects. Therefore the rights of the suspects in the criminal investigation process have to be considered as well. However in the present environment we can see that suspects are not considered innocent until proven guilty. Therefore, in this paper I have made certain recommendations in order to avoid such violations, including minimizing the impact of other laws and regulations, which impact on the investigation process, which was intended to be conducted by the CCP Moving to an inquisitorial system entails granting more powers to Magistrates to engage in investigations, and take practical action to protect the rights of suspects.

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¹ SC.FR. App. no.328/2002

²Charles D. Weisselberg, 'Mourning Miranda' California Law Review, Vol. 96:1519, p. 1520

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INTEGRATING HUMAN RIGHTS INTO W.T.O. LAW: TRANSLATION AND ‘BILINGUALISM’.

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INTRODUCTION

The issue of the possible conflicts between the values and goals of trade and those of human rights has entered into a new stage after the establishment of the World Trade Organization (WTO) in 1995. Trade liberalization now has a system by which inconsistency with WTO obligations can have serious legal and economic consequences for WTO Members, if they lose in binding dispute settlement. Human rights violations do not have the same kind of legal framework for implementation. There were fears that therefore trade rules would be able to override human rights and environmental concerns and a hierarchical system would be created. But since it is now accepted by the WTO Appellate Body in *US-Gasoline* that WTO law should not be interpreted in clinical isolation from public international law, the interpretation of the WTO Agreements could allow some space for the integration of international human rights into trade law. The approach in dispute settlement with regard to recognizing human rights has been restrained, avoiding human rights rules, principles or terminology and limited to the acknowledgment of certain public concerns as legitimate policy objectives e.g. public health but not ‘Right to Health’ (not as ‘rights’ that could be balanced with trade).

Furthermore, those who want to promote human rights in the interpretation of WTO Agreements must contend with both the constraints of the rules of interpretation according to the Vienna Convention on the Law of Treaties (VCLT) and with the fact that they are attempting to balance values rooted in two different legal regimes within the context of only one of them. It is the latter aspect that will be focused on in this research. It is suggested that an approach that takes ‘bilingualism’ into account (competence in the concepts and interpretation of both human rights and trade regimes) may be more successful in identifying the challenges and possibilities in interpreting the policy space for integrating human rights with WTO interpretation, than working on the assumption that there is one common language between trade and human rights.

METHODOLOGY

This research is an analysis of the inter-relationship of WTO law and Human Rights law regimes. As an alternate or additional view to the usual approach to interpretation of international agreements according to the Vienna Convention on Law of Treaties or the human rights approach, this paper seeks to apply the principles of language translation to explain the challenge of integrating human rights with trade law. It is a library-based research.

RESULTS AND DISCUSSION

The preamble to the Marrakesh **Agreement Establishing the World Trade Organization recognizes that** “...relations in the field of trade and economic endeavor should be conducted with a view to raising standards of living”. However, there are no direct references or linkages either in the trade law discourse or in the interpretation of WTO law, to the role of human rights (especially economic, social and cultural rights and the Right to Development) in this endeavor. In contrast, Reports of the UN Economic and Social Council and UN High Commissioner for Human Rights have referred to Human Rights being a code of values which can legitimately

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signal the ethically acceptable limits of economic policy measures and economic functioning and that it can also encourage a ‘human rights approach’ or human rights compatible interpretation of WTO law (UN 1997, UN 2002). The usefulness of human rights in a trade context is also that it strengthens the position of vulnerable groups in relation to their governments and vulnerable governments in their relations with the international economic institutions.

So far, the Panels and Appellate Body have been able to avoid the phrase ‘human rights’ altogether in Reports, and a search of disputes found the term itself mentioned in the text of a Report in only ten disputes and only in particular types of situations. The usual circumstances where ‘human rights’ is referred to in WTO Reports is mainly two-fold: (1) when the European Union refers to European Court of Human Rights decisions to support its arguments, usually as analogies to matters of procedure and not substantive rights (in *US-Hormones Suspension*, *Canada-Hormones Suspension*, *EC-Aircraft*, *US-Stainless Steel* as well as a somewhat convoluted reference in the *Thailand-Cigarettes*) and (2) the references in Panel Report footnotes to unsolicited amicus curiae briefs presented by organizations with names containing the term ‘human rights’ (in the Panel Reports *Brazil-Tyres*, *EC-Biotech*). There are also two references in former GATT Panel cases (the un-adopted *US-Tuna II* and *Japan-Leather III*). There has not been any reference to human rights by governments in current WTO dispute contexts to strengthen any claims of acting on legitimate policy objectives.

In recent years a great deal of effort has been taken for co-operation with regard to human rights and trade issues and the situation is no longer a simply antagonistic ‘human rights vs trade’ position, but much more complex. But even if human rights are referred to in trade discourse, there is usually something about the references and analysis that is jarring to a person trained in human rights. The academic debate between Ernst-Ulrich Petersman, Phillip Alston and Robert Howse wherein Alston (2002) and Howse (2002) reacted to Petersman’s analysis on human rights and trade is a prime example of this. The Office of the High Commissioner on Human Rights has the list of human rights documents on its website which lists the International Bill of Human Rights, the Core International Human Rights Instruments (core treaties with monitoring bodies) and a non-exhaustive list of other conventions, declarations, principles, rules and guidelines. In none of these documents is there to be found a ‘human right to trade’ as referred to by trade lawyers such as Petersman (2002). When the concept of ‘trade freedoms’ is referred to as if equal or even superior to human rights (especially social rights), without reference to the specialized regime in international law that deals with both the definition of particular human rights and the relationship between different rights, this only adds to the serious ‘mis-translation’ problem.

The kind of ‘translation’ problem raised by Petersman and other trade lawyers, whether intentional or a bona fide misunderstanding due to a lack of ‘bilingualism’ (the expertise in and use of both the languages of trade and human rights), can be called the ‘human rights = trade problem’. It is a problem since it confuses concepts in its simplification of similarities between the two regimes and also hi-jacks human rights terminology for liberalization of trade. Unlike those who play down the divergences in favour of an uncomfortable and artificial harmony, there is another approach that believes that human rights and trade do not share the same language and vocabulary and are caught in a ‘dichotomy of discourses’ caused by the differences in the foundational norms of the two regimes (Jackson, 2006).

The position of this paper is that it is important to acknowledge the existence of two different legal languages – those of trade liberalization and human rights – expressed in the context of different ‘legal cultures’. If this is acknowledged, then there exists along with the task of treaty interpretation according to the Vienna Convention on the Law of Treaties, the task of translation

of human rights language into the language and context of trade – and doing so in manner that human rights language retains its essential nature of defending human dignity.

The Role of Language in human rights and trade discourse should not be underestimated because “Language and text can create, shift, or maintain ideologies” (Collins 2009). As is common with language when it links with power - whether the power of ideas or power in society - the same language can be used in different ways by those who see themselves on opposing sides of an issue, to wrest control of it to themselves. Trade rights and human rights can be called also the “international language of power and the language of resistance” which have both been born in the same cradle of European enlightenment, though they have matured differently, grown apart and are perhaps now attempting, with some difficulty, to reconcile (Ishay 2008). The development of human rights language has since been part and parcel of revolt against authority or reorganizing of social structures. The most important developments occurred during the turmoil of 20th century and at this time human rights became a more universal language. Ishay (2008) notes that the language of human rights was added to by the socialists and the labour movement (though this is not often taken notice of) and points out that the composition of the Human Rights Commission in 1945 consisted of persons of widely differing philosophical backgrounds and further that UNESCO had carried out a study to support worldwide support for principles of human rights in different cultural and philosophical contexts. Therefore it is important to remember that the human rights regime contains and is nourished by far more than either a liberal or libertarian concept. Thus, it can be argued that when trade experts such as Petersmann, speak of fundamental rights of ‘freedom of trade’, contract, property rights (of investors and companies), ‘producer rights’ and ‘liberty rights’ it is ignoring the path that human rights has taken in its development in favour of an outdated and limited view that is not in line with post-World War II developments in human rights terminology including the right to development or the human rights approach to assessing economic policy.

The language of human rights has been said to be “possessed of its own brand of logic and inner beauty” (Orend 2002). But trade lawyers can say the same of the trade law regime, especially the WTO system, The application of language translation theory could correctly highlight the problem in the human rights and trade law discourse as well as offer a solution. According to Larson (1998), the success of a translation is measured by how closely it measures up to the ideals of being accurate, natural and communicative – to abstract the meaning of a text and reproduce that meaning with what could be very difference forms of a second language. Larson identifies that there can be bilingual translators as well as translators that work from their first to second language or vice versa. The purpose and audience also play a role, as can be imagined. So a translator can target the source language community or the receiving/target community. But in practice of translation, and in the context of the two legal regimes abovementioned, translators/lawyers need to switch from source to target audience and back again in the same text (‘dual orientation’). So getting as close to ‘bilingual’ as possible is advisable.

CONCLUSIONS/RECOMMENDATIONS

While there is potential for integrating human rights in the interpretation of the WTO Agreements, those engaged in this task must contend with the with the fact that they are attempting to the balance values rooted in two different regimes within the context of one of them. It is important, in taking on this task, to acknowledge the existence of two different legal languages – those of trade liberalization and human rights – expressed in the context of different legal cultures. If this is acknowledged, then there exists along with the task of treaty interpretation according to the VCLT, the task of translation of human rights language into the language of trade. For a translator to re-express meaning from source to receptor language, a competence in

both is needed. This need for ‘bilingualism’ in the integration exercise is usually overlooked or downplayed. This paper suggests that, as in the exercise of language translation, the minimum standard should be that trade lawyers discussing and applying human rights must be ‘bilingual’ in both their discourse and application of human rights in the interpretation of trade rules; and human rights lawyers should be aware of the tendency in trade law towards ‘mis-translation’ of human rights concepts and terminology and be able to recognize and respond in such a manner that the trade lawyers can fully understand. Understanding the limitations of ‘language competency’ (or incompetency) is needed - and perhaps there can also be a better understanding of your own ‘language’ or area of expertise in attempting an “accurate, natural and communicative” translation into another regime.

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THE IMPACT OF TECHNOLOGICAL ADVANCES ON CONTRACT FORMATION IN SRI LANKA

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INTRODUCTION

Every human being born to this world will inevitably enter into contracts himself or herself or have others do so, on their behalf. Obtaining the basic needs of food, clothing and shelter, as well as securing education, training and employment all involve contracts. Therefore the journey from womb to tomb is strewn with contracts of a formal and informal nature.

While the need for contracting has existed since the beginning of time, the methods by which such contracts are formed have not remained constant but been subject to constant change. Informal verbal agreements have given way to more formal written contracts while major changes in contract formation occurred when it became possible to contract without the contracting parties being in the actual presence of each other at the same place and time. While the 'Postal Rule' postulated in *Adam v Lindsell* (1818) was the landmark case of such contract formation, the progressive development of communication mechanisms from telephones, telexes and facsimiles to internet, short messaging services (SMS) and e-mail have created more complex issues in identifying the moment of contract formation.

While several requirements need to be satisfied in order to create a legally valid contract, of key concern in the context of communication, is the time of communication of acceptance, as this marks the point which completes agreement and the commencement of a binding contract. The Objectives of this research are

- To identify the areas where new issues regarding the point of creation of a contract have arisen due to technological innovations

- To understand how the law of Sri Lanka has developed to deal with these instances.

METHODOLOGY

This research is normative in nature. It will involve documentary analysis of relevant case law and statutory provisions in arriving at the conclusions to the study.

RESULTS AND DISCUSSION

Adam v Lindsell (1818) marked the first departure from the recognized rules of contract formation. The case postulated that in the event of communication of acceptance posting of the letter of acceptance was the point of acceptance, (and the place of acceptance) for the purpose of identifying the moment agreement was completed. Loss of mail and delays in the postal service were considered irrelevant and were the risk of the party who chose post as a medium of communication.

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Telex, fax and telephone communication which followed led to the realization that there could be instantaneous as well as non-instantaneous methods of communication when the contracting parties were not in each others' presence. Thus in *Entores v Miles Far East Corporation* (1955) the courts had to decide the point at which a valid contract was created, when communicating via telex. Lord Denning in his judgment highlighted the fact that when contracting through telephone and telex, the party sending the acceptance would know immediately whether the acceptance had been received at the other point or not. Therefore he held that the time and place where the acceptance was received was the relevant point at which the agreement would be deemed to be completed. He further held that if the one party in a telephone or telex transaction does not receive the acceptance (due for example to lack of paper or ink in the printer or an unclear telephone line) but does not request the information again the sender would, reasonably, believe that the acceptance has been received so that there would be a valid contract. The case of *Entores* thus distinguished non-instantaneous communication methods such as the post from instantaneous communications equating the latter with face to face transactions. This position was followed in the House of Lords decision of *Brinkibon Ltd v Stahag Stahl und Stahlwarenhandels-gesellschaft mbH* [1982] and the Court of Appeal decision of *The Brimnes, Tenax Steamship Co Ltd v Owners of the motor vessel Brimnes*[1974]. Although the *Brimnes* dealt with termination by telex, it becomes relevant in terms of the rule it stated as to time of receipt of a telex, which it held to be the time the message is received by the relevant party. In this case, although notice of termination was sent during office hours of one working day, it was only seen by the other party on the next working day. However the termination was considered to be valid as at the time of receipt of the telex on the first day.

The most recent technological advances have come in the nature of the World Wide Web or internet which has opened the doors to a myriad of possible methods of forming contacts including online transactions and contracts formed through e-mail.

Quite often internet transactions take place via websites set up by various persons wishing to sell items or services online. When do such transactions mature into valid legal contracts? As Halberstam (2008) states, whether an advertisement to sell an item appearing online is an invitation to treat or an offer is an important question. He states that if it is an offer, most often it will have a button to 'accept' and that the contract will be completed by a click wrap which he states is similar to an offline signature. Thus in *Hotmail Corporation v Van Money Pie Inc* (1998) when a click wrap agreement of Hotmail which contained a term preventing use of e-mail accounts to distribute spam was violated by the defendants, they were held to be in breach of contract.

Hajri (2011) comments that usually in online transactions an order form has to be filled online and the seller is required to inform acceptance of the order, so that the online advertisement is most often only an invitation to treat. Hajri cites the example of Argos who in 1999 mistakenly advertised their televisions of £ 299.99, as £2.99, but who escaped liability as the advertisement was only considered an invitation to treat. However clear terms and conditions to which the buyer assents when entering into the contract can prevent pricing errors leading to valid contracts being formed at low prices. Thus in 2003 Amazon.com was able to cancel contracts where computers of £274.99 were mistakenly marked £7.32, on discovery of the error. However in a similar situation in 2002, when Kodak advertised £300 camera's mistakenly at £100 and orders for over 2000 cameras were accepted the company went ahead and honoured these contracts. In the Singaporean Court of Appeal case of *Chwee Kin Keong and others v Digilandmall. Com Pte Ltd* (2005) where due to an employee's error, printers of \$3864 were marked at \$66 and e-mails confirming the acceptance of the offers to buy had been sent to the buyers the courts declared the contracts void on grounds of mistake.

The issue also arises as to whether e-mail and online transactions should be dealt with in an equal manner. E-mail contracts are often used in the modern business world. Controversy has arisen as to whether such contracts are legally valid and if so whether they should be considered instantaneous or whether the postal rule should apply to them. Issues arise as to what happens if the e-mail is sent but not read for sometime or if the message is not communicated to the intended person by the person who reads it, or is deleted by mistake or the e-mail arrives in the night or outside business hours. The fact that contracts can be formed by an exchange of e-mails has been recognized through case law including *NBTY Europe Ltd. (formerly known as Holland & Barrett Europe Ltd) v Nutricia International BV* [2005] where the court upheld the validity of a settlement agreement reached through offer and acceptance made by e-mail. In *Olivaylle Pty Ltd v Flottweg GmbH Co CGAA* (2009) decided in the Federal Court of Australia Logan J stated obiter that an e-mail contract was completed when the electronic acceptance reached the buyer, i.e. when it entered the buyer's information system. However this position has not been conclusively decided to date.

While both the cases of *Chwee Kin Keong and others v Digilandmall. Com Pte Ltd* (2005) and *Olivaylle Pty Ltd v Flottweg GmbH Co CGAA* (2009) considered e-mail to be almost instantaneous, VK Rajah JC in *Chwee Kin Keong* stated that internet sales were more likely to be considered instantaneous than e-mails, while web advertisements were most likely to be considered as invitations to treat.

With access to internet and e-mail becoming available on mobile telephones and the increased availability of computer facilities as well as internet connectivity in homes as well as laptops, and palmtops which ensure access at any place and at any time while on the move these modes of communication are in reality more likely to be instantaneous. However Rajah J.C. seems to consider e-mails as being less likely to be instantaneous given the process through various routers and service providers it must traverse to get from one party to the other.

In the case of *Marine Star (Pvt)Ltd. v Amanda Foods Lanka (Pvt) Ltd.* (2007) Justice Chitrasiri of the Commercial High Court of Colombo after a due consideration of both the Electronic Transactions Act and the Evidence Ordinance decided that a Short Message Service (SMS) could also be used as a legally valid document. While this judgment did not directly deal with contract formation but with admissibility of electronic evidence, it is contended that this case could be used as a foundation to prove the existence of contracts formed via SMS in the future

Many of the contentious issues surrounding electronic contracting have been answered in Sri Lanka in a very timely manner with the introduction of the Electronic Transactions Act No 19 of 2006 which in chapter 3 (sections 11-17) deals with electronic contracts. This Act is based on the United Nations Commission on International Trade Law or UNCITRAL's Model Law on Electronic Commerce of 1996. Accordingly Section 11 recognizes the enforceability of electronic contracts, while section 12 states that a message would be considered to have originated by a person if it has been originated by him, by someone authorized by him or by an automated information system. Section 13 states that an electronic communication can be acknowledged through any method of acknowledgement and that if acknowledgement is a requirement failure to do so will lead to the communication losing validity. Section 14 of this Act is important because it identifies the time and place an electronic communication takes place. Section 14(1) sets out two rules, to identify the time of dispatch of an electronic communication. If the message is sent to another person in the same information system, the time of dispatch is the time it is received by that other person, but if it goes to someone outside the particular information system dispatch occurs when the message leaves the original sender. Section 14(2) deals with time of receipt of a communication, which would be the time relevant to acceptance of a contract. Here there are 3

possible times of receipt; first if the receiver has mentioned the information system to which the information must be sent, receipt occurs the moment it enters that system; secondly if the message is sent to another address of the receiver (but not the system mentioned) receipt occurs when the person actually retrieves it; thirdly if no information system is mentioned receipt occurs when the message enters the system of the intended receiver. Section 14(3) defines the place of dispatch as that of the sender while the place of receipt is that of the receiver or addressee. Section 17 ensures the validity of electronic contracts, signatures and even contracts formed through automated systems without human intervention. It should also be noted that section 23 excludes transactions such as those for immovable property, creation of a bill of exchange, wills, power of attorney and certain trusts from the application of the Act. Thus it would appear that time of contract formation can be identified by using section 14, to identify the time of receipt and dispatch of an acceptance as Section 26 of the Act includes offer and acceptance within the meaning of communication.

In the UK the Electronic Commerce (EC Directive) Regulations 2002 sets out rules which must be followed when transacting with consumers within European Union member states. It requires the retailers or service providers to supply information including an explanation of the technical steps required to place an order as well as clear details regarding price, service provider, terms and conditions of the contract, acknowledgement of the order and how to amend input errors when placing an order. These guidelines protect the consumer as remedies for their breach are also included. However there are presently no such regulations protecting consumers entering into electronic contracts in Sri Lanka.

CONCLUSIONS

It is clear that due to technological developments, issues regarding contract formation have required revisiting. The new modes of communication, which enable communication even without human intervention, out of working hours and twenty four hours of the day lead to complexities in identifying when, and where contracts are finalized. The old rules are at times inadequate to cover emerging situations especially with the advent of the World Wide Web. While the judiciary has offered some answers to these complex issues, legislation has taken the welcome step of clarifying some of the issues as to time and place of dispatch and receipt of communication. Interestingly Sri Lanka which is viewed as a country which is normally slow to bring about legislative change has been proactive in this respect and has kept abreast with countries such as the US, China and Singapore in providing some answers to a still evolving area of law although safeguards such as those provided in the UK are still lacking. The issue also still remains as to whether internet transactions, especially e-mails, should be dealt with under the postal rule or whether it has now evolved into an instantaneous method of communication. It is this point that would enable a clear application of the law set out in the Electronic Transactions Act.

However it is noteworthy that the concept of freedom to contract, which even the above provisions of the Electronic Transactions Act keeps untouched, enables a person to avoid the difficulties which maybe encountered in use of modern technology to form contracts, by a careful drafting of the contractual terms and clearly expressed modes of ascertaining the time and place of formation of a contract.

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THE QUESTION WHETHER THE EXTENSION OF THE DETENTION PERIOD AFFECTS THE RIGHTS OF SUSPECTS: A CRITIQUE OF THE NEW ACT.

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INTRODUCTION

Crime is considered as an inevitable feature of every society and it is as old as human civilization. When a crime is committed, it does not proceed as an isolated issue but involves many other agencies at different levels. The criminal justice process starts from the moment of lodging a complaint in the police station. Since a crime is considered as an offence committed against the state, the police start their investigation into the complaint. In this investigation process, the law enforcement officials are trying to find out the truth in relation to the crime and sometimes they identify persons who are under suspicion of having committed it. Once, identified, and until the person formally charged by the prosecutor within the jurisdiction of the tribunal, he is considered as a suspect. However, the 'suspect' is also recognised as an individual who is entitled to rights which are not necessarily applicable to those who are accused and then convicted. These rights include prevention from arbitrary arrest, right to know the reason for the arrest, protection from unnecessary detention and protection from being tortured. Production before a Magistrate within the specific period is also considered a vital protection to which a suspect is entitled. Together with the 1978 Constitution and the Code of Criminal Procedure Act (CPC) of Sri Lanka a suspect could be detained up to 24 hours. However, with the Code of Criminal Procedure (Special Provisions) Act of 2012 this period was extended up to 48 hours. Though the government described this attempt as a path way to conducting a proper and effective investigation this has been criticized on many grounds. This researcher is trying to test the below mentioned hypothesis in this scenario by analyzing advantages and disadvantages of the new law.

METHODOLOGY

The hypothesis of "will the extension of the detention time period from 24 hours to 48 hours before producing a suspect before a Magistrate, affect to the suspect's rights?" will be tested through this research. The research will be based on both primary and secondary data which includes international conventions and domestic legislation in the area of suspect's rights. This research will consider both substantive and procedural laws and the analysis will be based on academic and judicial writings found in journal articles and reports. Additionally the author had some interviews with police officers to clarify some points which arose during the study.

RESULTS AND DISCUSSION

Justice Sharvananda stated in his writing that,

'...law allows the police to arrest but delegates to the Magistrate the judgment whether to detain or not. The suspect's constitutional rights are thus safeguarded...Policemen should not be made judges of the legality of their own arrest.'

The purpose of this provision is to enable an officer acting under judicial authority, who is a neutral and independent person, to make an impartial decision as to whether the arrest, which was made under executive authority, was legal, and whether further detention is necessary under the circumstances.

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Article 9(3) of the International Convention on Civil and Political Rights (ICCPR) provides that “anyone arrested or detained on a criminal charge shall be brought promptly before a judge or other officer authorized by law to exercise judicial power”. Article 13 (2) of the 1978 Constitution of Sri Lanka, provides that every person held in custody, detained or otherwise deprived of personal liberty shall be brought before a judge. Section 37 of the Code of Criminal Procedure states that in the case of arrest without a warrant, the suspect must be produced before a Magistrate within twenty four hours. This 24 hour time is calculated exclusively for the time necessary for the journey from the place of arrest to the Magistrate. According to the 2007 Special Provisions Act to the Code of Criminal Procedure, this time was expanded to 48 hours. The 2007 Act continued for two years and then lapsed. In 2012 a new law was passed, namely the Code of Criminal Procedure (Special Provisions) Act which stipulates that suspects arrested without a warrant could be detained for 48 hours in the case of 15 offences.

When discussing the case law some progressive judgments which recognized the rights of suspects can be noted. These include *Abasin Banda v S.I. Gunarathe and others* [(1995) 1 Sri L R 244], which recognized the 24 hour limit as the maximum time for production before a Magistrate. Where, in all the other circumstances of the case, it was unreasonable to delay production before the Magistrate, the person making the arrest would be acting in contravention of Article 13 (2). In the case of *Senarathne V Punya de Silva* [(1995) 1 Sri L R. 272] Amarasinghe J stated that “...detention being unnecessary and unreasonable was not according to procedure established by law and it was therefore in violation of the petitioner’s fundamental rights guaranteed by the Constitution. In *Faiz vs. Attorney General* [(1995) 1 Sri LR 372], the Petitioner was arrested at about 6.30 p.m. on 26.04.1991 and produced before the Magistrate on the following evening within the prescribed 24 hour maximum period, and remanded till the 29th and released on bail. The Court found that action to be a violation of Article 13 (2). Justice Fernando explained that in the circumstances of the case the detention was unnecessarily prolonged. This is clearly a violation of 13 (2). Similarly, in *Mohamed Haniffa Sithi Marliya V R. Mallawa Kumara* [S.C (spl) Application No. 293/1999, S.C Minutes, 21st September 2001], the overnight detention of a female suspect without any reason was held to be in violation of Article 13 (2) of the constitution.

The major threat of this extension is that, this can lead to the increase of torture in police custody. Currently, torture techniques seemingly are the foremost tool of ‘investigation’ used by police forces. In a recent press release, the Human Rights Commission of Sri Lanka reported that the highest number of complaints received by the Commission related to police abuse and brutality. Forty eight hours can lead to an increase in a likelihood of torture and abuse of detainees taking place routinely at police stations. It can be argued that this extension of the time period will not benefit the individuals. Moreover it can be considered a weakness where Sri Lanka is moving away of from the obligation undertaken with the ICCPR. More relevant could be abuse of power where those political dissenters could be subject to arbitrary arrest and perhaps torture under the new provisions.

CONCLUSIONS/RECOMMENDATIONS

As mentioned earlier in police stations, torture is used as the methods/modes of getting information. We have to have an alternative for torture, which could take place the moment a suspect is arrested. Things will only worsen with the introduction of detention up to 48 hours; the suspect will not be subject to anyone’s scrutiny – not the doctor, nor the Judicial Officer not even his lawyer or his family. There are instances of the disappearance of individuals who remain missing after being in police custody. Police officers must be deterred from using torture in any form and trained in new techniques of investigation and provided with the latest technology in regard to investigations. Use of techniques such as DNA and other testing methods to assist in the

process of investigation also should be encouraged. There are many other things to be improved within the police. The officials should also be educated about human rights standards and proper investigation methods.

The independence of the institutions is important to have a fair criminal justice system. However with the abolishing of the independent commissions such as the Police Commission and Judicial Services Commission with the adoption of the 18th amendment the problem has become worse. While appointments, promotions and related matters are not done in an impartial manner, it is increasingly difficult to find professional conduct from officers. The report entitled “The State of Human Rights in Ten Asian Nations -2011” mentioned that, ‘when the state curtailed the rights of the people no room is left for the judiciary to intervene and invalidate any illegal interference into the rights of the people. Basically, the liberties enshrined in the Magna Carta do not exist for the people of Sri Lanka now.’ It is high time that Sri Lanka ensures impartial institutions. Law and justice is the last bastion of hope of individuals. The curtailment of people’s rights by using arbitrary organs of the government should be reduced.

The existing laws also have some defects. For example the 1994 Torture Act falls short of satisfying these obligations because its definition of torture does not correspond to the definition in the United Nations Convention Against Torture; the 1994 Act does not establish universal jurisdiction for acts of torture. Further, the Act does not directly provide that superior officers should be held liable for acts of torture committed by their subordinates. The introduction of penalties if such acts are committed would be suitable as a deterrent to their use however not if the victim dies, this then should be paid to the family as penalties to the perpetrators and compensation to the victims. There is no specific right for compensation. The introduction of a system of compensation to the victimized party and pain by the informant would be suitable and fitting method of stopping allegations against another. There should be reformation for the above defects. Moreover, there is a need of substantial reform in the 2007 ICCPR Act bringing in line with the spirit as well as the substantial rights ensured by the ICCPR. The other main aspect is that the people are not aware of their rights. Robert Browning said “Ignorance is not innocence but sin. With regard to law, it is a disaster.” Awareness programs are important to enhance the level of education of individuals.

Finally: it can be concluded as only extension of the detention time period from 24 hours to 48 hours before producing to a Magistrate without adjusting other procedural defects will open a room for violation of suspect’s rights and it will not enhance the effectiveness of the police investigation.

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THE RIGHT TO INFORMATION IN SRI LANKA: A COMPARITIVE OVERVIEW WITH DEVELOPMENTS IN SOUTH ASIAN COUNTRIES

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INTRODUCTION

According to Seyoum Hameso, “Information has always been the basis for knowledge. Lack of information contributes to knowledge deficiency, leading to powerlessness. Freedom of information, in that sense, implies a form of empowerment or, better still, it signifies freedom from ignorance from servitude and ultimately the freedom to choose. An informed person is an empowered person”. In this modern era, democracy does not mean a mere representative but a participatory process. Without the right to information, it is not possible to have a democratic process such as participation and engagement in a country. Right to information is one of the most powerful tools that ensures democracy and good governance in a country by promoting public participation in the government. It empowers the citizen to act as an effective watchdog.

The right to information has been universally recognized as a human right in various UN Conventions such as the Universal Declaration of Human Rights (1948), the International Covenant on Civil and Political Rights (1966), the International Covenant on Economic Social and Cultural Rights (1966), and the European Convention for the Protection of Human Rights and Fundamental Freedoms (1950). Subsequently access to information as a human right has gained a prominent visibility in the context of environment and sustainable development. The Rio Declaration on Environment and Development recognized that environmental issues were best handled with the participation of citizens and that each individual shall have appropriate access to information concerning the environment held by public authorities, including information on hazardous materials and activities in their communities and the opportunities to participate in the decision making process.

In Sri Lanka, there are no clear Constitutional provisions, which recognize the right to information. Article 10 of the Constitution recognizes that every person is entitled to freedom of thought, conscience and religion while Article 14 (i) (a) declares that, every citizen is entitled to the freedom of speech and expression including publication. This lacuna in the law compels the citizen to depend on interpretations of the above mentioned Articles adopted by the judiciary in fundamental rights case law.

OBJECTIVES OF RESEARCH

The objectives of this research are:

1. To examine the extent to which domestic laws of Sri Lanka have recognized the Right to Information and the manner in which the constitutional provisions have been interpreted by the judiciary
2. To carry out a comparative analysis of the Sri Lankan statutes in relation to other South Asian Countries on this topic.
3. To recommend a legislative framework on the Right to Information in Sri Lanka including amendments introduced to the Fundamental Rights Chapter of the Constitution of Sri Lanka (1978).

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METHODOLOGY

The study is based on normative research analyzing the effectiveness of the International Human Rights framework, foreign legislation on the subject, local Constitutional provisions and legal mechanisms. Extensive studies were carried out adopting analytical methods on current international law and local legislation and mechanisms for the recommendations with regard to legal reforms to be introduced in the future.

RESULTS AND DISCUSSION

The right to information can be guaranteed in different ways, either constitutionally or through legislation. This right could be implemented through executive actions too. Constitutional recognition of the right to information as part of the fundamental right to freedom of speech and expression or as a specific fundamental right is the most effective method of implementing the right. Though the fundamental rights chapter has no specific constitutional provision that has a direct bearing on the subject, the judiciary of Sri Lanka has recognized this right to a certain extent through judicial interpretation of the right to freedom of speech. But the inherent weakness of this method is that interpretation can be changed depending on the nature of the Bench of judges. In *Vishvalingam v Liyanage*, (1984) the Sri Lankan Supreme Court has underlined the importance of public discussion on this aspect which demanded that for its full realization, the right of the person to receive information should be recognized.

It was evident that the Constitutional provisions relevant to the right to information have been subject to limitation by other constitutional provisions in the same chapter and other legal restrictions on this issue. Article 15(2), 15(7) and (8) stipulate the Constitutional restrictions on the exercise of this right. These restrictions range from interests of racial and religious harmony, parliamentary privilege, contempt of court, defamation and national security, public order and the protection of public health or morality. Other legislation such as the Official Secrets Act No 32 of 1955, Official Publications Ordinance No 47 of 1946, Public Security Ordinance No 25 of 1947 and Prevention of Terrorism Act No 48 of 1979 too contain restrictions on the exercise of the right.

The Supreme Court of India has not only recognized the right to know as a part of freedom of speech and expression but also accepted the link between the right to know and the right to life and liberty. Thus, in *Reliance Petrochemicals Ltd V Proprietors of Indian Express Newspapers Bombay Pvt Ltd* the Indian Supreme Court opined that "... the right to know is a basic right that citizens of a country aspire under article 21 of our constitution." Research has shown that with the implementation of the Right to Information Act of 2005 of India, the quality of life of the people has been improved and the level of corruption has been reduced to a certain extent and also accountability on the part of public officials and politicians has been improved. There had also been an increase in the number of cases where the courts have given orders to provide details of the decision making process. Due to acceptance of the fact that constitutional provisions on the right to information alone is not sufficient to safeguard this right, many other Asian countries such as Pakistan, Bangladesh and Nepal have adopted separate legal frameworks such as 'Freedom of Information' or 'Access to Information' for the purpose of ensuring the right to information

The study revealed that the right to information does not have any meaning unless there are clear constitutional or statutory provisions on the exercise of that right. A law on Right to Information will set out the extent of information that can be provided and the mechanism to enforce the right. It was also been revealed that agitation on the part of the general public enforcing political parties to introduce a law on the right to information has not been successful. The development in other

jurisdictions has proved that introducing the right will promote transparency, good governance and also minimize bribery, corruption and waste in the public sector as the people get a right to question the practices of state officials and politicians.

CONCLUSIONS AND RECOMMENDATIONS

The experiences in other countries have shown that recognition of this right through constitutional provisions alone is not sufficient and that a separate legal framework needs to be introduced to strengthen the Constitutional provisions. An amendment introduced to Article 14 (1) (a) of the Constitution of Sri Lanka recognizes the specific right to information, and adoption of a separate law on the right to information introducing the mechanism to enforce the right is necessary. Introducing a separate law on the subject includes identifying the persons who are responsible in the state machinery to provide information within a compulsory time frame. An enforcement mechanism in the event of a contravention of the statutory provisions and the punishments that can be imposed for non compliance has become an essential part of the assertion of the right to information. A separate provision should be included in the proposed legislation regarding the security and safeguards afforded to mass media including print and electronic media and to the people who question with responsibility the corrupt practices especially those of politicians. Without such safeguards mere recognition of the right will be of no value, given the present situation in the country.

Under the proposed legislation all State Departments, Authorities, Statutory Boards, Commissions, Universities and local government authorities are required to appoint Public Information Officers in their respective organizations, to maintain and update their websites on a regular basis, and to use new information and communication technologies such as email facility to provide information. Since the right to information includes the right to receive information in one's mother tongue, relevant provisions in the Official Languages Act and other statutes should be enforced requiring public officials to send prompt answers to queries made by the general public in the language used in the query.

In the context of global developments on this subject, introduction of separate legislation on the specific area of right to information has become the need of the hour in Sri Lanka to protect and promote the fundamental freedoms of thought, conscience, speech and expression including publication.

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RELATIONSHIP MARKETING ORIENTATIONS OF SALESPERSON IN BANKS: IS THAT GENDER SENSITIVE?

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INTRODUCTION

The term “Relationship Marketing (RM)” has become a popular concept among the practitioners of marketing, as well as academics, during the last decade. During the twentieth century, RM gained wide recognition following discussion on RM which began to dominate the marketing agenda. During this period RM was probably the major trend in marketing and certainly the major (and arguably the most controversial) talking point in business management (Egan,2003). As learning organizations have close relationships with other organizations, it is important to focus on the relationship management program which can be critical for their growth. It is a firm’s potentials and competencies such as an ability to build effective relationships, an ability to sense changes in environments, and an ability to innovate, that will support an organization leveraging its valuable resources, including relational stakeholder-based assets, and, consequently, facilitate the creation and delivery of quality, value-laden solutions (Jarrat,2004).

It is useful to understand the buyer and his/her behaviour first to forecast the reflection of his/her action. According to Saxe and Weitz (1982), salespeople who are customer-oriented take actions aimed at increasing long-term customer relationships and avoid actions that increase the probability of an immediate sale at the expense of sacrificing customer interests. Hence selling is considered to be of paramount important in marketing and the lifeblood of marketing. Customer oriented selling and relationship building will play a vital role in this regards. According to Williams and Attaway (1996), the firm’s marketing success is largely dependent upon the sales force, because these individuals are the ones who have the most “immediate influence on customers.” The most important method by which the marketer may manage the “buying experience” is through the implementation of customer-oriented sales tactics (Crane, 1991; Grewal & Sharma, 1991; Sharma, 1997).

Many researchers have focused on relationship marketing orientation through a gender perspective as well. According to Chodorow (1978) women are more “relationship focused” than men. It has been discussed how this tendency develops from a psychoanalytic viewpoint. In sales management literature, it can be observed that saleswomen place a higher value on interpersonal and social aspects of their job, while men place a high value on career-oriented factors (Palmer and Bejou, 1995). This has been further established by the research done by Helgesen (1990), Sparks and Callan (1997), and Oakley (2000) as well.

Hence the following research problem has been advanced in this study.

“Is female salesperson more relationship marketing oriented than male?”

RESEARCH METHODOLOGY

The study is based on the Sri Lanka banking sector, which is considered competitive despite the global and local macro economic downturns. The financial sector has still maintained an 8.9% contribution to GDP in 2012 (Central Bank, 2013). In that the role of licensed commercial banking sector can be considered as important (contributing 48.2% of total assets of the major financial institutions). Six major private commercial banks were selected to make the sample representative because of the growing competition in the sector. From these six banks, a random

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sample of 180 respondents (CROs-Customer Relationship Officers) were selected. Finally 146 CROs responded. But only 130 questionnaires were selected due to incompleteness of questionnaires. The analysis was performed by SPSS 13.0 ®.

Relationship marketing has been operationalized in terms of the variables of relationship commitment and trust. Endogenous constructs of Morgan and Hunt (1994), "The commitment-trust theory of relationship marketing", used (with modifications) as indicators of trust and relationship commitment. *Relationship marketing* refers to the relationship commitment and trust (Morgan and Hunt, 1994). *Commitment* refers to "an ongoing relationship with another that is so important as to warrant maximum efforts at maintaining it" (Morgan and Hunt, 1994). *Trust* refers to "willingness to rely on an exchange partner in whom one has confidence" (Morgan and Hunt, 1994).

RESULTS AND DISCUSSION

In order to understand whether the relationship marketing orientation differs according to the gender category the same test of independent sample t-Test was performed and the following results can be observed.

Table : *Relationship marketing and gender*

Male		Female		Independent Sample T-Test and P value
Mean	Std. Dev.*	Mean	Std. Dev.*	
3.71	0.472	3.77	0.530	-4.993(0.000)**

Std. Dev.* - Standard deviation

**significance at 0.05 level

Source: Survey Data 2012

According to Table 5 it can be observed that female salespersons (CROs) are more relationship marketing oriented than male salesperson. Hence there is enough statistical evidence to claim that 'Female CROs are more relationship marketing oriented than male CROs'.

CONCLUSION

The relationship marketing orientation of salesperson towards the customer and their gender also has been measured in this study. As discussed earlier the trust and commitment of salesperson are used as variables to measure the relationship marketing towards to the customers. It can be concluded that relationship marketing has been well practiced by women salesperson than men. This can be observed by using the literature of different contexts as well. Fournier (1998) used female informants exclusively in her study of brand relationships and suggested that women "exhibit more and stronger interpersonal relationships and brand involvement". This is supported by Stout and Villegas (2004) who explain that "females have a psychological orientation toward a communal outlook characterized by emphasis on interpersonal relationships, affiliation and attachment to the self and other". This is further confirmed by Hook *et al.* (2003) and they argued that women "place more emphasis on love, affection, the expression of warm feelings and emotional sharing". Moreover Bhagat and Willimas(2008) elaborated that women will exhibit

higher levels of intrinsic interpersonal commitment with higher levels of relationship strength. Similarly in the financial services industry, women have been found to give greater importance to both intangibles (empathy and assurance) and tangibles (Paswan *et al.*, 2004). Hence it is clear that women can be considered as important in relationships as men. It can be recommended for the banks to be considering the implications for their future recruitment and HRM practices as well.

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**DETERMINANTS OF POST HACCP IMPLEMENTATION BEHAVIOR IN TERMS OF
WILLINGNESS TO ADOPT NEWER FOOD SAFETY METASYSTEMS:
CASE OF SRI LANKAN AGRI-FOOD PROCESSING SECTOR**

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INTRODUCTION

The decision on adoption of food safety controls by firms will depend on perceptions of internal costs and benefits of adoption versus non-adoption (Caswell *et al.*, 1998), as well as the potential for improvements in industrial performance, for example market share, profitability etc. In turn, this will reflect, for example, the characteristics of the firm, its objectives, the type of product it manufactures, and the environment in which it operates (Herath *et al.*, 2007; Jayasinghe-Mudalige, 2009).

Prior to adoption of enhanced food safety metasytems such as HACCP (Hazard Analysis and Critical Control Points), firms are guided by number of “intended benefits”, which the decision-makers within the firms believe, will be obtained as an outcome of adoption. Firms vehemently target enhancement in operational performance as well as strategic growth within the sector through the implementation of a food safety control system. During the post-implementation period, however, firms evaluate whether the intended benefits of adoption have been “realized” or whether unexpected costs have risen in comparison. This evaluation and subsequent judgments are critical factors that will influence firms’ decisions on whether to continue with the certification into the future and also decisions that might arise upon upcoming or novel quality assurance systems in the long term. In light of this, this study was aimed at assessing whether HACCP certified agri-food processing firms in Sri Lanka wish to continue the same metasytem or opt for an advanced and more stringent food safety controls, for example ISO 22000 (Jayasinghe-Mudalige *et al.*, 2013).

METHODOLOGY

Theoretical Framework

We propose that a HACCP certified firm’s decision to continue with the metasytem (i.e. “Stayer”) or to adopt an enhanced newer system like ISO 22000 (i.e. “Advancer”) is triggered by a number of firm and market-specific characteristics that can be expressed as follows:

$$D_i = \beta_0 + \beta_1 (\text{SAI}) + \beta_2 (\text{MCB}) + \beta_3 (\text{OPB}) + \beta_4 (\text{GMP}) + \beta_5 (\text{ICS1}) + \beta_6 (\text{ICS2}) \\ + \beta_7 (\text{VIN}) + \beta_8 (\text{REV}) + \beta_9 (\text{EMP}) + \beta_{10} (\text{MKT}) + \beta_{11} (\text{HTI}) + \varepsilon_i$$

Where, in D_i ($i = 0$ for Stayer and $i = 1$ for Advancer). The right-hand side variable SAI represents the overall corporate view of the firm towards this decision, which is augmented by five strategic aspects, namely: profitability, competitive advantage, organizational growth, legal protection, and social responsibility, all of which act as motivators for firms private action on

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HACCP implementation, and is estimated using the equation given below (the value of SAI ranges from 0 to 1).

$$SAI_{ik} = (\sum X_{ik}) / M$$

Where: SAI_{ik} = Strategic Aspect Index of k^{th} strategic aspect for the i^{th} respondent; X_{ik} = Scores given by i^{th} respondent to k^{th} strategic aspect (*Very important* = 1, *if not* 0; M = Maximum Potential Score for all k^{th} strategic aspect (see, Table 1 below for description of other variables). Perceived benefits to the firm by adoption of HACCP (i.e. post adoption experience) are reflected in two other variables: (1) Market Capacity Benefits (MCB) (i.e. reflects the firm’s ability to deal with market forces), and (2) Operational Proficiency Benefits (OPB) (i.e. enhanced internal operational efficiency of the firm) (Jayasinghe-Mudalige *et al.*, 2013). The scores given by respondents on four-point likert scale for a set of statements explaining these phenomena (see, Figure 1) were used to derive values for each variable. Data Collection and Analysis

A structured questionnaire-based survey was carried out with the owner/quality assurance manager of agri-food processing firms (n= 51), which have obtained HACCP certification through the Sri Lanka Standards Institution, to collect data during January to March 2013. Given the dichotomous nature of dependent variable (i.e. Stayers, Advancers), the Probit Regression technique (Ashford and Sowden, 1970) was employed to estimate the coefficients of variables of the empirical model using *Stata* statistical software (Ver. 11.2).

RESULTS AND DISCUSSION

Descriptive Statistics of the Sample

Nearly 40% of firms wish to stay with the certified system at present (i.e. “Stayers”), while other 60% have already taken steps or possess a plan to go ahead with an enhanced newer system (i.e. “Advancers”). In fact, a majority of “Advancers” are dealing with export markets (83%), earning higher revenue (64%), and employ a relatively higher number of employees (66%) in the firm as compared to the Stayers

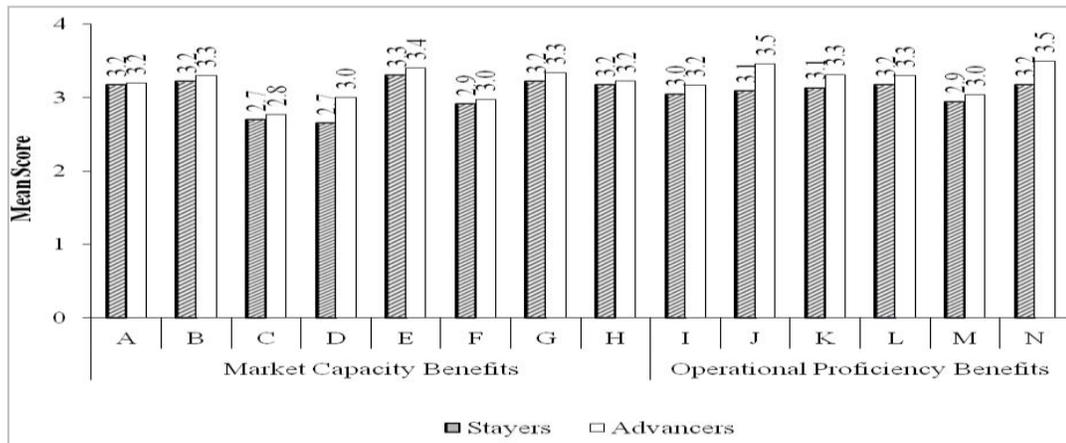


Figure 1 reports the Mean Scores of the statements used to derive MCB and OPB. It was found that overall mean score of MCB is 3.04 (“Stayers”) and 3.15 (“Advancers”), while that is for OPB is 3.09 (“Stayers”) and 3.29 (“Advancers”). The ISO 9000 and ISO 14000 environmental management system was implemented by 68 and 23 percent of Stayers and 54 and 31 percent of Advancers, respectively.

Note: A= Increased sales, B= Reduction in customer complaints, C= Obtain a higher price for products, D= Access to new markets, E= Satisfaction of current customer requirements, F=

Differentiation, G= Improvement in company image, H= Ability to meet anticipated customer requirement, I= Prolonged shelf life of products, J= Improved ability to meet government requirement, K= Improved efficiency of the firms, L= Minimizing product related problems, M= Reduced interference of stakeholders groups, N= Meeting industry / trade association standards

Outcome of Probit Regression

The estimates of coefficients of variables used in the model and their marginal effects are reported in Table 1.

Table 1. Outcome of the Probit Regression

Variable	Description	Estimate of Coeff.	Standard Error	Marginal Effect
<i>Perceived Benefits of HACCP system</i>				
SAI	Strategic Aspect Index	12.710	0.973*	0.249
MCB	Market Capacity Benefits	0.922	0.673	0.119
OPB	Operational Proficiency Benefits	6.791	0.817*	0.180
<i>Presence of Other System in Place</i>				
ICS1 _{D2}	ISO 9000 (Yes = 1, No = 0)	-0.644	0.509	0.201
ICS2 _{D2}	ISO 14000 (Yes = 1, No = 0)	-1.110	0.715	0.070
GMP _{D2}	GMP (Good Manufacturing Practices) (Yes = 1, No = 0)	2.064	0.524	0.014
<i>Firm Specific Characteristics</i>				
VIN	Vintage of the firm	1.541	0.007	0.129
REV _{D2}	Revenue of the firm (<50 Million = 0 Small; 51-100 Million=1 Medium; >100Million = 2 Large)	8.415	0.787	0.054
REV _{D3}		9.327	0.632*	0.286
EMP	No of employees in the firm	10.490	0.001*	0.250
MKT _{D2}	Type of the market (Domestic = 0; Export = 1)		0.673*	0.324
HTI	Time duration with HACCP	0.501	0.060*	0.110

***Significance at 5%**

Note: SE=Standard error, ICS1_{D2} Implemented ISO 9000, ICS2_{D2} Implemented ISO 14000, GMP_{D2} Implemented GMP, REV_{D2} 50-100 Million, REV_{D3} >100 Million, MKT_{D2} Export market

The variables MKT_{D2}, REV_{D3} and EMP were significant at $\rho=0.05$ and possess a relatively higher marginal effect. The results show that the probability of “Stayer” becoming an “Advancer” increases by 32.4% and 28.6% as a firm moves towards export markets [compared to domestic market] and into the larger revenue category (>100 Million) [compared to lower revenue category (<50 Million)]. Similarly, as the number of employees increase, the probability of “Stayer” being an “Advancer” is increased by 25%.

The results suggest that a firm which deals with the export market (as EU and China) and who gains larger revenue shows a tendency towards adopting a newer food safety system which may be due to their potential for investment with the extra capital earned. Further, over time, as a firm realizes more benefits, this drives the firm towards a newer system as they intend to be more internally efficient as an “Advancer”. Moreover, the vintage of the firm (VIN), other systems in place (i.e. GMP, ISO 9000, ISO 14000) and Market Capacity Benefits (MCB) did not make a significant contribution in explaining why a “Stayer” becomes an “Advancer”.

CONCLUSIONS/RECOMMENDATIONS

The outcome of the analysis suggests that firms who have adopted HACCP wish to implement a newer food safety system as it would provide them with competitive advantage, including their ability to act strategically on profitability, competitive advantage, organizational growth, legal protection, and social responsibility as well as internal efficiency of the firm.

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STUDY ON CUSTOMER SATISFACTION IN STATE BANKS IN TRINCOMALEE DISTRICT

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ABSTRACT

In recent years, the banking industry has undergone massive changes in scope and the nature of its environment. Technological advances, increased competition, the expansion of economic activities, as well as the growing diversity of customer needs have contributed to the increase and the scope of banks' services. This research aimed to investigate the level of customer satisfaction in state banks in the Trincomalee district. The study has been done with a number of account holders for the last five years in these three state banks. Even though all three are state banks, the record shows a low number of savings accounts in the National Savings Bank even it though it was established for promoting the saving habit among people. Therefore, special reference has been given to the National Saving Bank, comparing it with the other two state banks, People's Bank and Bank of Ceylon. Consequently this research investigation has been conducted by analyzing the marketing mix strategy. Marketing mix strategies are seen as a main strategy of winning competitive advantage. The objective of this study is to evaluate the satisfaction level of product, price, place, promotion, people, physical evidence and process (Service Marketing Mix: 7Ps) among the state banks. A structured questionnaire was used to collect the primary data from 150 respondents. Questionnaires were divided and 50 questionnaires for each bank were randomly issued and secondary data were collected through books, journals, magazines and annual reports. The collected data were analyzed using the techniques of univariate analysis with the help of Statistical Package for Social survey (SPSS). The level of customer satisfaction of three state banks in Trincomalee district varies based on the variables considered. Compared with the other state banks the National Savings Bank customers revealed that they have a moderate level of satisfaction whereas the Bank of Ceylon and People's Bank have a high level customer of satisfaction. This bank has to improve the level of customer satisfaction by improving the service quality of the bank, by granting more benefits for the savings account holders, and applying new information technology such as ATM facilities, worldwide online money transfer, and e-banking system.

Key words: Bank, 7 Ps, Information Technology and customer satisfaction.

PROBLEM STATEMENT

The number of accounts for the last five years from 2007 to 2011 in the state banks clearly show that there is a big difference among state banks' services in the Trincomalee district.

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Table 01

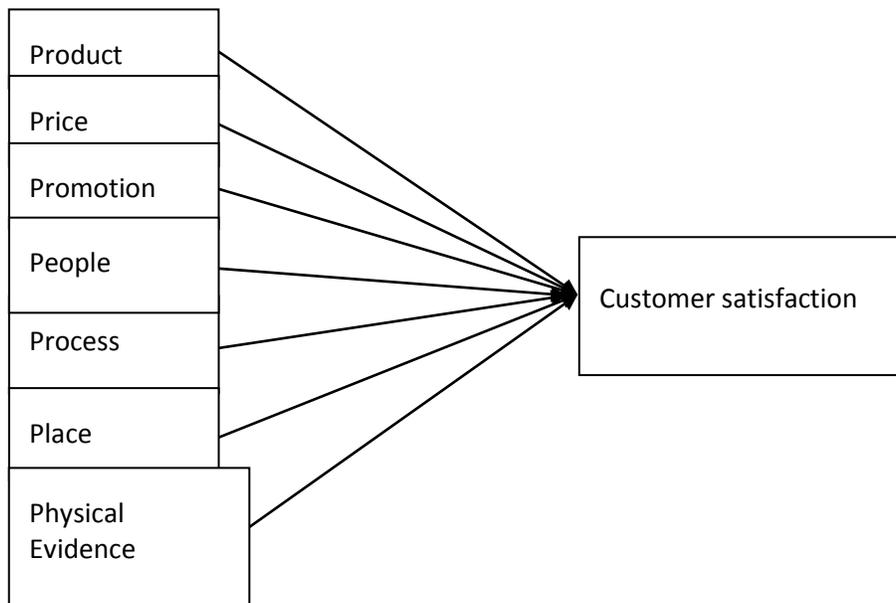
No	Banks	2007	2008	2009	2010	2011	Total
01	National savings Bank	9951	10178	11526	12897	13261	57813
02	Bank of Ceylon	178,940	179,740	169,960	139,988	75,000	743,628
03	People's Bank	157,650	169,780	168,580	169,000	100,000	765,010

(Source: Regional branch/main branch in year 2012)

OBJECTIVES OF THE STUDY

- To evaluate the level of customer satisfaction among the three state banks.
- To find the factors contributing to customer satisfaction.
- To find out the use of Information Technology.

CONCEPTUAL FRAME

Figure 01

(Source: Develop for the research purpose)

There are 7 P's determining Marketing Mix. They are Product/Service, price, place, promotion, people, process and physical evidence. Each piece determines service marketing. As a result bank pricing must be competitive and must entail profit. The pricing strategy can comprise discounts, offers and the like. Place, refers to the place where the customers can obtain the service and how the service reaches out to that place. This is done through different channels, like internet, wholesalers and retailers. Another one is promotion; it includes the various ways of

communicating to the customers of what the bank has to offer. It is about communicating the benefits of using a particular product or service rather than just talking about its features. People refer to the customers, employees, management and everybody else involved in it. It is essential for everyone to realize that the reputation of the brand that is involved with is in the people's hands. Process, refers to the methods and process of providing a service and is hence it is essential to have a thorough knowledge of whether the services are helpful to the customers, whether they are provided in time, if the customers are informed beforehand about the services and many such things. Finally, Physical (evidence), refers to the experience of using a product or service. When a service goes out to the customer, it is essential that you help them see what he is buying or not.

OPERATIONALIZATION

Table 02

Variable	Indicator	Scale	Q.No
Product	Availability of deposit products	Five point Likert Scale	07
	Availability of loan products		08
	International transactions		09
Price	Low interest rate for Loan facility	Five point Likert Scale	10
	Special interest rate for deposit		11
	Service Charges		12
Promotion	Raffle	Five point Likert Scale	13
	Advertisement		14
	Special offer		15
People	Willingness to help	Five point Likert Scale	16
	Complaint handling		17
	Individualized attention		18

Process	E-banking	Five point Likert Scale	19
	SMS Banking		20
	Service process		21
Place	Accessibility	Five point Likert Scale	22
	Location		23
	ATM Service		24
Physical Evidence	Printed receipt	Five point Likert Scale	25
	Certificate		26
	Statement		27

(SoDevelop for the research purpose)METHODOLOGY

SAMPLE SELECTION

The target population for this study includes all the account holders of state banks in the Trincomalee district.

SAMPLING

Table 03

Banks	Town & Gravates Region	No of account holders in year 2011	No of questionnaires
National savings Bank	Main Branch	13,261	50
Bank of Ceylon	Main Branch Bazar Branch China bay Branch	33,467 32,250 9,283	50 (23+21+6)
People's Bank	Main Branch Twon Branch	65,813 34,187	50 (33+17)

(Source: Regional branch/main branch in 2011)

For this research 150 samples were randomly selected from savings account holders in the Trincomalee district. Around 188,261 customers were identified as having bank accounts from which 150 customers were taken as samples for this study. These 150 questionnaires were divided and 50 questionnaires for each bank were randomly issued. In evaluating data if the mean value falls in between $1 \leq X \leq 2.5$, $2.5 < X \leq 3.5$ and $3.5 < X \leq 5.0$, the decision was low, moderate and high level of satisfaction respectively. Secondary data were collected from the statistical hand book, journals, magazines and websites.

RESULTS AND DISCUSSION

PRODUCT

Evaluating the product/service of the three state banks. The highest level of customer satisfaction is seen from the PB and BOC. A moderate level customer satisfaction is seen

from the NSB. NSB has a mean value 3.18 with standard deviation 0.670. BOC has mean 3.53 with standard deviation 0.815. PB has mean value of 3.68 with standard deviation 0.768.

PRICE

Prices relate to special interest rate for senior citizens, fixed deposit, day interest for saving amount, interest rate for loan and service charges. The highest level of customer satisfaction is seen from the PB. The moderate level of customer satisfaction is seen from the BOC and NSB. In the NSB price mix has mean 3.38 with standard deviation 0.470. BOC has mean 3.43 with standard deviation 0.325. PB has mean 3.59 with standard deviation 0.362.

PLACE

The place is one of the variables and it has four indicators. distance, internal and external environment, ATM facilities and mobile services. The highest level of customer satisfaction is seen from the BOC and then PB. The low level of customer satisfaction is seen from the NSB. NSB has mean 2.23 with standard deviation 0.724. BOC has mean 3.85 with standard deviation 0.782. PB has mean 3.81 with standard deviation 0.812

PROMOTION

The variable of promotion includes lottery, seasonal loan re-payment method, attractive advertisement and cash advance. The highest level of customer satisfaction is seen from the PB and then BOC. The moderate level of customer satisfaction is seen from the NSB. NSB has mean 2.99 with standard deviation 0.572. BOC has mean 3.63 with standard deviation 0.801. PB has mean 3.93 with standard deviation 0.854.

PEOPLE

Evaluating the efficiency, customer care, experience and relationships of the three state banks in Trincomalee district the highest level customer satisfaction is seen from the BOC and then PB. The moderate level customer satisfaction is seen from the NSB. NSB has mean 3.22 with standard deviation 0.702. BOC has mean 3.66 with standard deviation 0.869. PB has mean 3.83 with standard deviation 0.967.

PROCESS

The process depends on adaptation of Information Technology. Online banking, telecommunication services, SMS banking and Part payment are evaluated. The highest level of customer satisfaction is seen from the BOC and then PB. The lowest level of customer satisfaction is seen from the NSB. In NSB Information Technology has mean 2.43 with standard deviation 0.724. PB has mean 3.81 with standard deviation 0.812. BOC has mean 3.85 with standard deviation 0.782.

PHYSICAL EVIDENCE

Physical Evidence includes printed receipt, certificate, and statements. Evaluating the physical evidence of the three state banks the highest level customer satisfaction is seen from the PB and then BOC. The moderate level customer satisfaction is seen from the NSB. In NSB it has mean 2.98 with standard deviation 0.572. BOC has mean 3.63 with standard deviation 0.801. PB has mean 3.66 with standard deviation 0.854.

OVERALL ANALYSIS

Evaluating the overall analysis of the three state banks in Trincomalee district the highest level customer satisfaction is seen from the PB and then BOC. The moderate level customer satisfaction is seen from the NSB. In NSB customer satisfaction has mean 2.91 with standard deviation 0.539 BOC has mean 3.65 with standard deviation 0.808. PB has mean 3.75 with standard deviation 0.910.

CONCLUSION

Customer satisfaction is a most important factor in the banking sector. In this research seven variables have been taken into consideration to assess the level of customer satisfaction of banking. The customer satisfaction pattern is changing day to day in this way; the banking sector has to update their product and services according to the trend in which it is most important for survival and existence of the sector. Illustrating the customer satisfaction in three state banks namely NSB, BOC, PB it appears that the level of customer satisfaction in NSB is low compared to the other two state banks. In view of the above it can be stated that the People's bank and BOC have a slight difference in the level of customer satisfaction. NSB has highest variation compared to the BOC and PB in the level of customer satisfaction. Therefore, it is important to find ways and means to increase the level of customer satisfaction in NSB.

RECOMMENDATIONS

Though NSB provides high rate of interest for savings between 5% - 6%, fixed deposit 8.5% - 14% compared BOC (Savings 4%-5%, fixed deposit 7.5% - 12.68%) and PB savings (Savings 4.25%-6%, fixed deposit 11% - 12%) the bank should give more attention on customers to fulfill their other requirements such as quick service, healthy communication, reduced interest charges for loan pawning and mortgage.

NSB should concentrate on increasing the infrastructure facilities of their branches by providing sufficient vehicle parking facilities, Seating facilities and tools and equipment for their customers. Also NSB should establish sub branches, where customers can easily reach the bank by travelling a short distance.

The bank staff should explain the benefits of the interest rate given by the bank in order for the bank customers to be more aware about the benefits of maintaining their savings in the bank. It should take necessary action to reduce the time in waiting at the counter section and other sections. The bank should appoint experienced staff for each task to facilitate completion of a customer's transactions in a short time

In the case of service hours NSB should take necessary action to provide more ATM facilities for customers to do their day to day transaction conveniently

NSB has also introduced new services such as providing double interest rates, providing gifts, scholarship, through innovation to each target group.

NSB should pay more attention to improving the staff morale as bank staff should treat the customer well and talk to them politely and should also fulfill their needs as early as possible.

The NSB has one main branch in Trincomalee District. But BOC has three branches; the main branch, Bazaar branch and Chinabay branch. People's Bank has two branches, the main branch and the town branch. This leads customers to deal with a bank closely and leads to increasing the number of customers. Therefore NSB should open more branches in the district in addition to the main branch, which can help increase the number of accounts and customer satisfaction in this bank.

Compared to the other two state banks NSB had very low satisfaction in relation to ATM facilities provided by the bank. Therefore NSB should make arrangements to provide ATM services for customers to make their day to day transactions more convenient. Also NSB should take more action to increase and improve the money transfer facilities for customers to get the services very quickly and easily without any delays. Furthermore the bank should provide for foreign exchange facility and facility to convert any country currency at any time. The bank staff should be trained to fulfill the customer's needs quickly without keeping the customer long time. NSB should offer more scholarship programmes to the account holders below 18 years such as children, students etc. The bank also should provide a lottery for account holders, seasonal gift vouchers, free tours, air tickets etc to their customers.

Also bank staff should take immediate action to attend to the complaints made by customers in order to reduce customer dissatisfaction. NSB should concentrate on increasing the infrastructure facilities of their branches, by providing sufficient vehicle parking facilities, Seating facilities and tools and equipment for the ease of their customers. Also NSB should establish sub branches in the Trincomalee district, where customers can easily reach the bank.

LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

There is no research without limitations. This study also has several limitations. First, the data for the objectives have been collected within one geographical location. For the purpose of business strategy banks' actual data and information are kept commonly secret. The study has been conducted based on people who respond to changing environments according to their needs and wants. Further research is needed to investigate the extent to which these findings generalize to other settings and to the national level with larger samples.

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EARNINGS MANAGEMENT, ACCOUNTING GIMMICKS AND DUMMY GIANTS

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INTRODUCTION

The “earnings” which are also called the bottom line or the net income is the single most important line item in financial statements (DeGeorge, Patel, & Zeckhauser, 1999). Any person irrespective of his or her knowledge of finance and accounting tends to refer the amounts of earnings of entities in order to draw up conclusions on their performance. Given the importance of earnings, it is crystal clear that managers are vigilant and have a vital interest in how they are reported. Here, managers evaluate the effects of available accounting choices so that they can make the best possible decisions for the entity. Theoretically, earnings indicate the extent to which an entity has engaged in value-added activities and accordingly assist resource allocation in capital markets (Lev, 1989). Therefore, managing earnings of an entity is equal to managing the future of that entity.

The Sri Lanka Accounting and Auditing Standards Act, No. 15 of 1995 and the regulations made under the Act have defined certain enterprises to be Specified Business Enterprises (SBEs). The Act imposes certain duties and obligations on SBEs and their directors, officers and auditors, the default of which would result in various penalties. Even though the current position of accounting in the country is considerably admirable, there are many accounting standard violations which can be identified by analyzing the annual accounts of certain SBEs. For instance, it has been revealed that certain SBEs have misstated their financial statements through improper valuation of assets, provisions and tax liabilities, recognition of unrealized incomes as realized incomes, incorrect computation of gains and erroneous capitalization of expenses all of which come under the umbrella term “earnings management.” Those accounting violations are mainly highlighted through qualified audit reports, and sometimes the Sri Lanka Accounting and Auditing Standards Monitoring Board (SLAASMB) as the main regulatory body which keeps an eye on these actions issue undertakings demanding rectifications in near future. Since these material misstatements directly affect the elements of financial statements and distort the true picture of those SBEs, it is quite questionable to determine how the agency theory is maintained under this kind of a fraudulent environment. In other words, it is interesting to observe why Sri Lankan SBEs use earnings management techniques to misstate financial statements even though there is a risk of losing stakeholders and corporate image.

As objectives, this research explores commonly and generally used earnings management techniques by SBEs and their implications on elements of accounting. It is expected that the achievement of these objectives would nourish academic, commercial and regulatory tiers of the country, and the findings have been aligned to agency theory in a way which may feed the existing literature on earnings management.

METHODOLOGY

This research applies the interpretivism approach. It implies a subjective epistemology and the ontological belief that reality is socially constructed. That is there is no one objective or universal reality that can be seen and that the reality or realities are constructed by social actors in social interaction. This also assumes subjective, multiple, mutable, and context-dependent realities

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(Collinson, 2012). As such, the objectives of the current study can be well explored through the application of an interpretative standpoint.

The multiple case study approach is adopted for the current research as the research strategy. This enables the author to gather evidence from a variety of scenarios and then filter the findings to meet the objectives of the research. Since earnings management has different dimensions, a broader area of it can be encompassed from the aforementioned research strategy.

Eight SBEs were selected for the current study in the light of the purposive sampling technique. The application of purposive sampling technique allows identifying most critical and relevant cases for the study. The selected SBEs for the current study represent both manufacturing and service sectors of Sri Lanka, and different financial periods so that a broad conclusion can be drawn on them. Moreover, it detects whether the earnings management techniques in both manufacturing and service sectors have similarities and have changed over time.

Semi-structured interviews were conducted with the Director and Manager of Technical Division of SLAASMB, Audit Manager and Assistant Audit Manager of PricewaterhouseCoopers. The duration of each interview was between 45 - 60 minutes. The interviews enabled exploring of the opinions, experiences, and feelings of the interviewees, thereby making the analysis sound and complete. Therefore, it can be identified as the best technique to gather data for this study. The information collected by the interviewees at SLAASMB helped to understand the regulatory background for the research problem and the audit managers' opinions gathered through interviews helped in analyzing the impact of earnings management on elements of accounting. In addition to interviews, data was also collected from review of publications of SLAASMB and annual reports of selected SBEs. The use of multiple sources in this manner facilitated the drawing of the conclusions of the study.

RESULTS AND DISCUSSION

The nature of SBEs is inherently ample in many aspects relative to ordinary type of businesses so that direct control and supervision are impractical. In this kind of a situation, the owners of the SBEs have to appoint some agents on behalf of them and with this, a principal (owner) – agent (manager) relationship originates. In an ordinary situation, both principal and agent try to maximize their utility or the return, and unfortunately both of them have different interests. However, it is usually the agent that has the information advantage over the principal (Adams, 1994) so that the expectations of the agent can be achieved as he wishes showing dummy performance to the principal.

The earnings management and management's response to material and significant misstatements can broadly be categorized into two main areas. Those are management disagreements with SLAASMB and management disagreements with auditors. Management disagreements with auditors can be further divided as misstatements for which undertakings were not given by SLAASMB and misstatements for which undertakings were given by SLAASMB.

One of the famous cases which can be analyzed under management disagreements with SLAASMB is the argument between TI PLC and SLASSMB on the biological assets valuation. The case is taken critically by both parties and neither of them is willing to give up their individual opinion even at the present moment.

The issue arose after publishing the annual report of year 2005/2006 by the company and as per SLASSMB's view, the plants of the TI PLC had been overvalued by violating the provisions in IAS 41 (Agriculture). The plants were valued by the company at a value in excess of Rs.5000

per plant whereas the replacement cost was likely to be around Rs.500. Furthermore, the discounts rates used by the company to measure future cash flows were also highly unrealistic. In the year 2011/2012, the company had made a revaluation of its biological assets and earned Rs.200 million gain which was also questionable to the auditors. These facts indicate how powerful the company is to keep its financial statements as it wishes irrespective of the regulatory involvement.

The moral hazard concept argues that shareholders would assess the managers' performance by looking at the financial outcomes of their businesses due to the inability of direct supervision (Subramanian, 2006). This behavior may lead to shrinking in the managers' duties because they know that direct supervision will not be exercised. Accordingly, the managers might put less effort to reflect the true picture of the business which is also called "taking it easy on the job". They tend to apply illogical judgment to massage the figures in the annual accounts. The following two cases reflect management disagreements with auditors for which undertakings were not given by SLAASMB.

In the annual report of L PLC for year 2009/2010, the auditors had made a qualification pointing some significant misstatements. The company had not made a provision for impairment of the carrying values of investments in two of its subsidiaries and the company believed that the subsidiaries would be able to improve its performance in the near future. However, one subsidiary had been incurring losses the accumulated loss of which was 329.4 million at the reporting date and the other one had met a going concern issue. L PLC had been applying its own judgments neglecting the audit recommendations.

NL PLC is an example for a SBE, the audit reports of which have been qualifying for years due to many reasons. In year 2009/2010 the company's annual accounts had been qualified because of an accounting treatment that did not comply with the Finance Leasing Act, No.56 of 2000. The correction of which would reduce the year's profit by Rs. 63 million. In year 2011/2012, several audit qualifications had been made in the annual accounts of the company. Three subsidiaries of NL PLC had identified revenue and costs related to construction contracts the amounts of which were substantially different from the amounts that had to be recognized. On the other hand, another three subsidiaries were incurring continuous losses indicating their inability to continue as going concerns. However, NL PLC had prepared its consolidated financial statements on going concern basis without making the required adjustments. Moreover, the accuracy, existence and completion of completeness, some balances in trade and other receivables were also unable to be verified.

As per the desk reviews carried out by SLASSMB, they identify some annual accounts which are qualified by the auditors and entail material and significant misstatements. Since the misstatements strongly affect the elements of the financial statements, the SBEs are required to resubmit the annual accounts with the stipulated adjustments.

According to the BDJW Ltd. case, the company had not provided for the diminution in value of an investment for the year 1999/2000 which is not temporary and agreed to write off Rs. 517 million after getting the directions from SLASSMB. If the company did not receive that kind of a direction, the financial position of the company would be overstated continuously regardless of the audit qualifications. It might help the managers to receive some performance based incentives, and specially grab the attention of current and potential shareholders by giving higher dividends and illustrating attractive ratios. The same misstatement can be observable in LC Limited the adjustment of which made a provision of Rs.147 million and in the case of LHC Limited, the company had not written off an irrecoverable portion of debt which amounted to

Rs.76 million that overstated the current assets, net assets and working capital of the company artificially.

There are certain situations where the SBEs try to keep expenses as assets in the statement of financial position and enhance the periodic performances accordingly. For instance, KH Co. Ltd had incurred expenses on architect's fees and other preliminary work related to a project which was suspended later. The incurred amount Rs.3 million had been recognized in the statement of financial position for the year 1999 as an investment rather than writing off to the statement of comprehensive income leaving a chance to overstate the asset base of the company. On the other hand, some SBEs tend to incorporate financial figures even though the reliability of which is not justifiable to the management staff as well. In the LKC Limited case, the company included a balance of Rs.1 billion in the statement of financial position for the year 2002 as inter-site current account under non-current assets. Even though the balance represented the net assets of the factory and hotel site at cost, management was unable to prove the accuracy of the value which had to be impaired later as per the directions given by SLASSMB.

It was revealed from the interviews that some managers are reluctant to accept audit opinions in order to rectify the misstatements in the annual accounts and they are very much confident about their judgments and future expectations. Moreover, the lack of awareness of the general public regarding the regulatory involvement in identifying material and significant misstatements and their insufficient financial sense give incentives to the managers to incorporate material and significant misstatements in their annual accounts.

CONCLUSIONS/RECOMMENDATIONS

As per the findings of this research study, there are some SBEs which are issuing financial statements with material and significant misstatements and qualified audit reports, but are not willing to accept their mistakes to the regulatory bodies of the country, especially to SLASSMB and ask for required adjustments. On the other hand, there are some SBEs which are having autonomy of their financial judgments so that the material and significant misstatements will not be adjusted until they are given a supreme order.

As far as the elements of financial statements are concerned, "assets" can be considered as the entrance of earnings management for many SBEs. Rather than increasing equity through the appreciation of incomes and gains, most of the SBEs tend to attack their assets base, and make a considerable hit to the bottom line of the statement of comprehensive income and strengthen the equity position accordingly. Further, it is evident that the earnings management techniques of manufacturing and service organizations are almost similar in nature and they have not been changed drastically over the time.

Due to the information asymmetry, managers are strong enough to finger the financial statements in their own ways and this might assist them to meet their personal goals while getting the attention of the current and potential shareholders. Moreover, the desk reviews carried out by SLASSMB to analyze the financial statements may not be the only cure for earnings management since SLASSMB is selecting the financial statements on a sample basis. The SBEs which are outside the selected sample can also have material and significant misstatements which shall not be corrected in future.

The risk of tarnishing the image of a SBE through these financial misstatements depends on the nature of the SBE and to which extent that SBE takes it as seriously. Earnings management will be a crucial concept especially for those SBEs that represent the financial market of the country such as banks and they always tend to avoid audit qualifications and keep their annual accounts

clean. SBEs which have a low business risk may go ahead with their opinions even under audit qualifications because they know that undertakings and publication of such errors may not be strong enough to discontinue their operations.

The main responsibility to identify the accounting gimmicks in the financial statements rests on auditors. In this regard, they should always ask for clarifications for vague accounting practices, demand alterations for inappropriate management judgments as much as possible and qualified and adverse audit opinions have to be given under worst scenarios. As mentioned by Adams (1994), appointment of in-house internal auditors may be a sound mechanism to mitigate the information shrinking and signal the principals that agents are acting in a responsible manner. Shareholders on the other hand should ask for true and fair financial statements especially when audit qualifications are entailed in the financial statements in which attractive figures have been presented. Shareholders should be vigilant about the financial aspects of their companies and responsible parties should be questioned regarding the accounting treatments which are subject to audit qualifications. In addition to that, the desk review process of SLAASMB has to be expanded more so that detection of material and significant misstatements can be improved. Furthermore, its findings should be spread out in different means so that the general public will be more aware of the seriousness of earnings management. Conclusively, the principal-agent relationship should be backed by management integrity, and the transparency in operations of SBEs will also be supportive to differentiate dummy giants from those that are real.

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THE IMPACT OF RELATIONSHIP MARKETING PRACTICES ON CUSTOMER LOYALTY –WITH SPECIAL REFERENCE TO LICENSED COMMERCIAL BANKS IN SRI LANKA

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INTRODUCTION

Sri Lanka, situated in the Indian Ocean near India, is a small island with a population of around 20 million. The economy of the country was liberalized in 1977, thus becoming the first South Asian country to open its economy. This open economic policy resulted in the expansion of the banking sector, and by 2004, there were 22 commercial banks established in the country. Among them, 11 were foreign banks, and the others were local of which two were state owned banks (Central Bank of Sri Lanka, 2004, p. 125). The two state banks are the largest in the country, and all the banks operate in the corporate banking sector.

total assets of licensed commercial banks are Rs.1058.6 million and with Rs.879 million fixed assets, domestic banking units have strong business power in Sri Lanka. Collectively the unit account for about 82% of commercial bank assets. Therefore the domestic banking unit (2 state banks and 9 domestic private banks) play a main role within the financial system, as they have the capacity to provide liquidity to the entire economy. Consequently, this study mainly focuses on the domestic banking unit of Sri Lanka.

Banks are also responsible for providing payment services, thereby facilitating all entities to carry out their financial transactions. On the other hand, banks can create vulnerabilities of systemic nature, partly due to a mismatch in maturity of assets and liabilities. Therefore, the soundness of banks is important, as it contributes towards maintaining confidence in the financial system and any failure may have the potential to impact on activities of all other financial and non-financial entities.

Banking customers take their finances seriously, and they expect their financial institution to do the same. In an industry of large, small, and in-between banking choices, what can really set your institution apart from the rest? Institutions that continue to grow market share keep their customers' needs as a priority. They consistently excel at personalized customer service and support.

The time has come for commercial banks to consider customer loyalty as a source of competitive advantage. It has been established that customers will not be impressed by only the core service attributes as other firms also provide similar offerings. The study of customer loyalty and business performance has been a focus in the customer relationship management. Therefore relationship marketing and customer loyalty plays an important role for an effective and efficient banking service. Thus, this research would have considerable value to identify the importance of relationship marketing for the banking industry in Sri Lanka to build consumer loyalty.

There are several studies which have been undertaken in the relationship marketing perspective by using different models in different countries, and these studies were also based on the effects of relationship marketing on the business performance of firms. Recently a few studies have systematically investigated how to employ marketing strategies to build customer loyalty. Also researches are rarely found which have been undertaken on the relationship marketing practices

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on building customer loyalty perspective to compete effectively. Therefore deficiencies persist in the understanding of the impact of Relationship Marketing practices (Trust, Commitment, Conflict Handling and Communication) on customer loyalty in order to achieve the competitive advantage. So this research addressed the theoretical as well as empirical gap between the Relationship Marketing Practices on customer loyalty. Based on that, the ultimate *objective of the research project is to examine the “impact of RM practices on Customer loyalty in Sri Lankan licensed commercial banks”*. Further this study investigates the relationship marketing strategies of local commercial banks and examines whether - after its implementation - customer relationships were strengthened through perceived improvements in the banking relationship and consequent loyalty towards the commercial banks of Sri Lanka.

Research question

“What is the impact of Relationship marketing practices on customer loyalty in licensed commercial banks in Sri Lanka?”

Research Objectives

The objective of the research is to examine the impact of relationship marketing practices on customer loyalty in licensed commercial banks in Sri Lanka.

Literature Review

Interest in the economics of long – lasting customer relationship has grown since the last decade. Relationship marketing refers to establishing, maintaining and enhancing relationship with customers and other partners at a profit, so that the objectives of the parties involved are met (Grontoos, 1994). This is achieved by a mutual symbiosis and fulfillment of promises (Ndubisi, 2003). The phenomenon described by this concept is strongly supported by on – going trends in modern business (Webster, 1992). Nelson and Ndubisi(2007) argued that the goals of relationship marketing are to create and maintain a lasting relationship between the firm and its customers that are rewarding for both sides, while Blobqvist et al (1993) offered key characteristics of relationship marketing ; every unit, activities of the firm are predominantly directed towards existing customers, it is based on interactions and dialogues and the firm is trying to achieve profitability through the decrease of customer turnover and the strengthening of customer relationships. Gummesson(1991) concluded that relationship marketing is a strategy where the management of interactions, relationships and networks are fundamental issues.

Copulsky and Wolf(1990) defined relationship marketing as a combination of the elements of general advertising , sales promotion , public relations and direct marketing to create a more effective and more efficient continuous relationship with consumers across a family of related products and services. They further explained , the relationship marketing process and key elements; 1) identifying and building a database of current and potential customers which records and cross –references a wide range of demographic, life – style and purchase information 2) delivering differentiated messages to these people through established and new media channels based on the consumer’s characteristics and preferences and 3) tracking each relationship to monitor the cost of acquiring the customer and the life time value of his purchases.

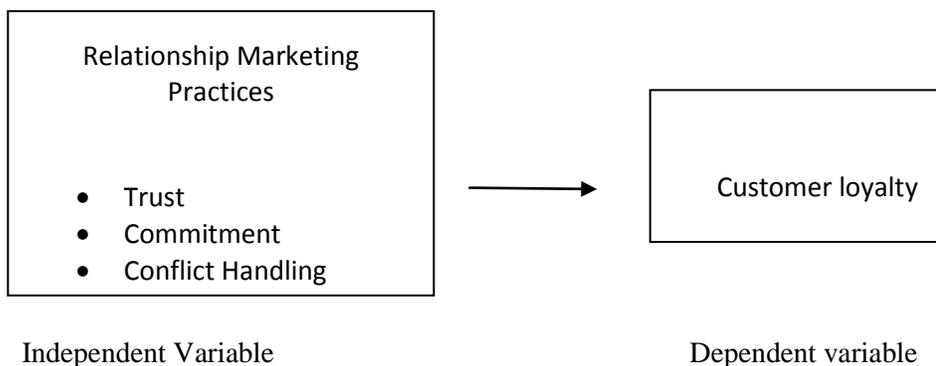
Marketing studies have theorized a number of key underpinnings of relationship marketing namely, trust (Morgan and Hunt,1994: Ndubisi et al.2004), equity (Ndubisi 2004), benevolence, empathy, (Ndubisi,2004) commitment (Morgan and Hunt, 1994), conflict handling(Ndubisi,2004), communication or sharing of secrets (Crosby 1990, Morgan and Hunt 1994) and competence (Ndubisi,2004). Kavali (1999) concluded that relationship marketing is about healthy relationships characterized by trust, equity and commitment.

Kotler(2003) define customer loyalty as the purchase from the company by its customers expressed as a percentage of their total purchases from all suppliers of the same product. Asker (1991) discussed the role of loyalty in the brand equity process and specifically noted that brand loyalty leads to certain advantages, such as reduced marketing cost and more new customers.

In increasingly competitive markets, being able to build consumer loyalty is seen as the key factor in winning market share and developing a sustainable competitive advantage. Oliver (1990) defines brand loyalty as “ a deeply held commitment to re – buy or re – patronize a preferred product/service consistently in the future, thereby causing repetitive same brand or same brand set purchasing , despite situational influences and marketing efforts which have the potential to cause switching behavior. This emphasizes the two different aspects of loyalty described in prior studies – behavioral and attitudinal. It has been argued that for loyal buyers, companies must invest in relationship building and customers. Building such relationships and intimacy will also culminate in stronger loyal customers (Ndubisi, 2004).

The development of customer loyalty is one of the most important issues that organizations face today. Creating loyal customers has become more and more important. This is due to the fact that competition is increasing, as never before, which has a great impact on many companies. To deal with this high concentrated market, businesses are attempting not only to attach and satisfy customers but also to create a long term relationship with these customers (Remler and Brown,1996). Creating satisfied and loyal customers is a critical matter for many corporations’ survival.

The above justification through literature paved the way for developing the following conceptual model.



Hypotheses

H1 : Relationship marketing practises used in the bank have a positive influence on customer loyalty in commercial banks.

Ha: There is a positive impact of customer trust on customer loyalty in Sri Lankan licensed commercial banks.

Hb: There is a positive impact of customer commitment on customer loyalty in Sri Lankan licensed commercial banks

Hc: There is a positive impact of better conflict handling methods on customer loyalty in Sri Lankan licensed commercial banks

Hd: There is a positive impact of customer communication on customer loyalty in Sri Lankan licensed commercial banks

METHODOLOGY

Quantitative methodology has been applied and a questionnaire was used to collect data. Among the 22 licensed commercial banks (Central bank of Sri Lanka, 2009), this study is restricted to local banks in Colombo district, as a result two public banks and nine private banks come under the local commercial banks in Sri Lanka. 1000 household customers were selected as the best representative and had been selected from 100 licensed commercial banks based on non-probability sampling method (quota sampling). Before the final data collection a pilot study was undertaken prior to data analysis, and data purification process was conducted to ensure suitability of measures (Churchill, 1979). For ensuring the reliability of scale, Cronbach's alpha is computed. Further content validity and construct validity had been applied, under the construct validity convergent validity, discriminant validity and nomological validity also had been tested. Before the data analysis appropriateness of data distribution was tested. In that manner, normality test and multicollinearity test were undertaken.

Finally multiple regression analysis has been used as data analysis tools and used to test the hypothesis (H1), and step wise analysis used to test the sub hypotheses (Ha, Hb, Hc, Hd).

RESULTS AND DISCUSSION

Table 1

Correlation between Relationship Marketing and Customer Loyalty

Relationship Marketing Practices	Customer Loyalty
Trust	0.87**
Commitment	0.62**
Conflict handling	0.32**
Communication	0.26**

** Correlation is significant at the 0.01 level (2-tailed)

Based on the above table, that there is a positive relationship between relationship Marketing Practices and customer loyalty in commercial banking sector in Sri Lanka.

Table 2 Dimensions of RM on customer loyalty (H1)

Hypothesis	Independent variable	Depend. variable	Unstandardized Coefficient Beta	Standardized Coefficient Beta	Sig.	Adjusted R ²
H1	Constant	Customer loyalty	0.618			0.652
	Trust		0.616	0.779	0.0	
	Commitment		0.522	0.607	0.0	
	Conflict Handling		0.149	0.329	0.0	
	Communicatio		0.057	0.152	0.0	

H1: There is a positive impact of relationship marketing on customer loyalty in Sri Lankan licensed commercial banks. Based on the table 2, Relationship Marketing has a positive regression coefficient value ($\beta = 0.618$) which has been significant at P-value of less 5% ($P < 0.05$). At the same time regressed model sufficiently fits the data; accuracy of predictability of the fitted model is medium and residuals also followed a normal distribution. It implies that relationship marketing with customers positively influences customer loyalty. At the same time adjusted R^2 (0.652) is at a moderate level, and this regression results show that the RM has strong positive effects on customer loyalty in Sri Lankan licensed commercial banks and 65.2% of change in customer loyalty is explained by RM in Sri Lankan licensed commercial banks.

These findings are in the line with Sweeney (2001) and Delgado et al (2005), who stated that there is a relationship between relationship marketing and loyalty. Based on that, the first hypothesis (H1) has been accepted. Further customer trust has strong positive effects on customer loyalty (78%), and commitment also have positive effects on customer loyalty (60%), at the same time conflict handling and communication also have an impact on customer loyalty, 32% and 15% respectively. But both (conflict handling and communication) don't have a strong impact on customer loyalty. In this manner, hypotheses Ha and Hb are accepted at the same time Hc and Hd are also accepted but partially.

CONCLUSIONS/RECOMMENDATIONS

This study tried to integrate the relationship between relationship marketing practices and customer loyalty, and found that "there is a strong positive impact of relationship marketing on customer loyalty in Sri Lankan licensed commercial banks". Thus, it has filled the theoretical as well as empirical gap between relationship marketing and customer loyalty. Besides, it shows that licensed commercial banks are implementing the relationship marketing on a moderate level in Sri Lanka. But Sri Lankan licensed commercial banks are implementing the relationship marketing practices on a moderate level. This shows that Sri Lankan licensed commercial banks have further room to improve their present level of relationship marketing practices.

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SERVICE QUALITY AND CUSTOMER SATISFACTION IN WESTERN UNION MONEY TRANSFER” (A COMPARATIVE STUDY BETWEEN PEOPLE’S BANK AND PRIVATE AGENTS IN JAFFNA TOWN)

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ABSTRACT

Customer satisfaction is the means to success of any organization. Service quality has a massive impact on customer satisfaction. This study analyzed “Service quality and Customer satisfaction in Western Union Money Transfer” (A Comparative study between People’s Bank and Private agents in Jaffna town). The rationale of this study was to carry out empirical testing, to study the level of service quality and customer satisfaction in both the People’s Bank and private agents and identifying the factors which influence the level of customer satisfaction. The sample comprised 80 customers, based on random sampling method. In this study, the relationship was tested through hypothesis testing using t-test and correlation and regression analysis. The decisive finding of this research was that there was a significant positive relationship between service quality and customer satisfaction in delivering Western Union money transfer services at both People’s Banks and Private agencies.

Key words: Customer Satisfaction, Service quality, Western Union money transfer

INTRODUCTION

Western Union is a money transfer service, which is an industry leader with an eye toward providing fast and reliable money and messaging services, with a history of pioneering service of more than 150 years. Western Union continues today to help consumers and businesses transfer money or make payments. Consumers can quickly and easily transfer money to more than 260,000 Western Union Agent locations in over 200 countries and territories worldwide - the largest network of its kind. In the Jaffna District, People’s Bank and private agents have entered into an agreement with MMBL money transfer. They offer Western Union Money Transfer services to add great value to their customers across the country, helping them receive money from abroad quickly, reliably and conveniently. According to the information obtained from Western Union money transfer, People’s Bank as a state bank, is the best credible agent of Western Union money transfer in Jaffna district. Therefore this study mainly compares peoples’ bank and other private agents, in relation to service quality and customer satisfaction in Western Union money transfer.

This study conceptualizes customer satisfaction based on the definition that customer satisfaction is the key to success. It is identified that these financial services which are meant for meeting the financial needs of customers, the services should be up the fullest satisfaction of the customers. “Satisfaction is the level of a person’s felt state resulting from comparing a product’s perceived performance in relation to the person’s expectations”(Philip kotler,1995). This study conceptualizes Quality based on the definition, “It is generally accepted that customer satisfaction often depends on the quality of product or service offering”. Quality is about those characteristics and features of a product or service that affects the ability of the product to satisfy the needs and desires of customers. Service quality can be explained as customers’ perception of how well a service meets or exceeds their expectations. Note that service quality is judged by customers, not by the quality from the customer’s point of view. Financial institutions may view service quality as, having friendly and knowledgeable employees, speedy service and the amount of services

provided to customers. Customer satisfaction can be considered as the essence of success in today's highly competitive world of business. Customer satisfaction is considered crucial for the financial success of service companies as customer dissatisfaction leads to customers switching to competitors (reduced customer loyalty) and the risk of adverse comments being communicated to potential clients. The competitiveness among financial institutions is increasing intensively today. Therefore, the financial institutions have to deliver high quality services to achieve customer satisfaction which leads to better financial performance. Gatewood and Riordan (1997) equated satisfaction with meeting the customers' needs and expectations by delivering goods and services to the satisfaction of the customer.). Parasuraman et al. (1985; 1988) initially described five dimensions of service quality: reliability, tangibles, responsiveness, assurance and empathy. Parasuraman et al. (1991a) argued that reliability was mainly concerned with the outcome of service whereas tangibles, responsiveness, assurance and empathy were concerned with the service delivery process.

Customer satisfaction is a measure of how products and services supplied by a company meet or surpass customer expectation. Customer satisfaction is an ambiguous concept and the actual manifestation of the state of satisfaction will vary from person to person and product/service to product/service. The state of satisfaction depends on a number of both psychological and physical variables which correlate with satisfaction behaviors such as return and recommend rate. The level of satisfaction can also vary depending on other options the customer may have and other products against which the customer can compare the organization's products. Customer satisfaction as a key performance indicator within business and is part of the four perspectives of a Balanced Scorecard and in a competitive marketplace where businesses compete for customers; customer satisfaction is seen as a key differentiator and increasingly has become a key element of business strategy. Organizations are increasingly interested in retaining existing customers while targeting non-customers; measuring customer satisfaction provides an indication of how successful the organization is at providing products and/or services to the marketplace.

, based on the literature, there is much empirical evidence which explains the relationship between service quality and customers satisfaction especially in financial and banking sector. This study was conducted to compare the customer satisfaction in Western Union money transfer at People's Bank with private agents. The service quality dimensions identified from the literature were taken to the study.

Research question of this study was, '**Does the Service quality influence on Customer Satisfaction in Western Union money transfer of both People's bank and Private Agents?**

OBJECTIVES

The main purpose of this study was identifying the impact of service quality on customers' satisfaction in both People's Bank and Private agents. Sub objectives are,

- To identify, why the service quality and customer satisfaction differ from People's Bank to private agents
- To study the level of service quality and customer satisfaction at each organization.
- To identifying the factors influences the level of satisfaction.
- To recommend solutions to overcome the problems and to improve customer satisfaction in those organization.

CONCEPTUAL FRAMEWORK

Based on the literature, the following conceptual framework was developed. There is a variety of factors that potentially influence customer satisfaction level that can be found in the literature. In this study the selection of independent variables is based on the functions and services of Money transfer service point by either People's Bank or Private Agents. Reliability, Customer & Employee Relationship and Speedy process were the independent variables which impact on the dependent variable Customer Satisfaction.

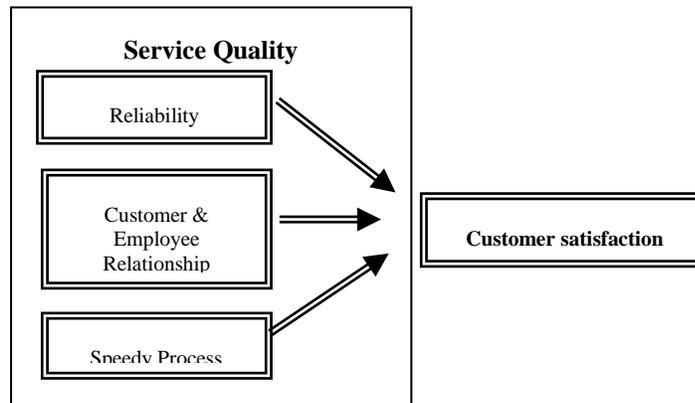


Figure 1: Conceptual Framework (Author developed)

From the literature review the following hypotheses are formulated for the study purpose.

- H₁:** There is a positive relationship between service quality and customer satisfaction.
- H₂:** There is a relationship between reliability and customer satisfaction.
- H₃:** There is a relationship between customers - employee's relationship and customer's satisfaction.
- H₄:** Speedy process also has relationship with customer satisfaction.

METHODOLOGY

This research will be an explanatory study. This emphasis here is on studying a situation or a problem in order to explain the relationship between variables. The sample of this study was composed of both customers of People's Bank and Private Agents. Sample size includes 80 respondents who were selected based on the random sampling. Data collected through questionnaire method.

The sample adequacy tested with KMO and Bartlett's test of sphericity, with the value of 0.69 and the normality tests produced the results which confirm the suitability to parametric statistical analysis.

Correlation analysis is used to find out the relationship among the variables and their strength. The scatter diagram is a diagram used to predict the relationship between independent variables and dependent variable by plotting the data on the graph area. Regression analysis describes to predict or estimate the impact of independent variable on dependent variable. Simple regression is used to find out the relationship between customer satisfaction and Service Quality which begins with a set of data values and determines a "best fit" equation of the firm. T-test was used to identify the significant difference. Significance difference for the customer satisfaction in both sector were tested by this statistical tool. Both correlation analysis and T-test analysis were used

to test the hypothesis in different ways. It provides for a more rigorous analysis. Statistical package for social sciences (SPSS.16.0) was used.

RESULTS AND DISCUSSION

Hypothesis Testing

H₁: There is a positive relationship between Service quality and customer satisfaction.

Table 1: Correlation relationship between Service Quality and Customer satisfaction in People’s Bank

Correlations			
		TSQ	TCS
TSQ	Pearson Correlation	1	.520**
	Sig. (2-tailed)		.000
	N	45	45
TCS	Pearson Correlation	.520**	1
	Sig. (2-tailed)	.000	
	N	45	45

** . Correlation is significant at the 0.01 level

The above table shows the r value of 0.520 which is significant. It indicates that there is a Moderate Positive relationship between Service Quality of People’s Bank and Customer satisfaction in getting the Western Union money transfer services.

Table 2: Correlation analysis between Service Quality and Customer satisfaction in Private agents

Correlations			
		TSQ	TCS
TSQ	Pearson Correlation	1	.611**
	Sig. (2-tailed)		.000
	N	35	35
TCS	Pearson Correlation	.611**	1
	Sig. (2-tailed)	.000	
	N	35	35

** . Correlation is significant at the 0.01 level

Above table show the r value of 0.611 which is significant. It indicates that there is Positive relationship between Service Quality in private agents and Customer satisfaction in obtaining the Western Union money transfer services.

Table 3: Correlation analysis between Service Quality and Customer satisfaction

Correlations			
		TSQ	TCS
TSQ	Pearson Correlation	1	.556**
	Sig. (2-tailed)		.000
	N	80	80
TCS	Pearson Correlation	.556**	1
	Sig. (2-tailed)	.000	
	N	80	80

** . Correlation is significant at the 0.01 level

Above table show the r value of 0.556 which is significant. It indicates that there is a Moderate Positive relationship between Service Quality and Customer satisfaction in People’s Bank and private agents.

Table 4: Regression analysis between Service Quality and Customer satisfaction

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.556 ^a	.309	.300	1.26427

a. Predictors: (Constant), TSQ

According to the regression analysis, 30% of customer satisfaction is influenced by service quality.

Scatter diagram for analysis between Service Quality and Customer Satisfaction.

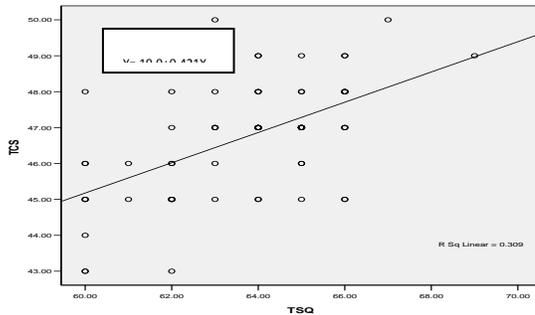


Figure 2: scatter diagram

Above scatter plot can be explained with the help of the equation $y = -19.9 + 0.421X$. It explained even though customer satisfaction is zero, Service quality will always be 19.9. It explained that the other factors influence on customer satisfaction. When the service quality increases by one, customer satisfaction will be increased by 0.421.

Comparison between service quality and customer satisfaction in both sectors

Table 5: Comparison between Service Quality and Customer satisfaction in both sectors.

	Correlation (r)	Regression (r ²)
People’s Bank	.520	.271
Private Agents	.611	.373

People’s Bank have positive relationship between service quality and customer satisfaction ($r=0.520$).when comparing private agents have high positive relationship between service quality and customer satisfaction ($r=0.611$) than People’s Bank services. According to the regression analysis, private agents’ service quality influences on customer satisfaction greater than People’s Bank. In people’s bank 27% of customer satisfaction is explained by service quality. In Private agencies 37% of customer satisfaction is influenced by service quality.

H₂: There is a relationship between reliability and customer satisfaction.

Table 6: T-test for Reliability and Customer satisfaction in People's Bank

	N	Mean	S.D	t-value	Sig.
Reliability	45	16.37	1.33	82.21	.000
Customer satisfaction	45	46.53	1.39	224.32	.000

The above table shows, Reliability t- value 82.21, customer satisfaction t-value 224.32. Sig. value is less than 0.05. So, it can be said that there is significant differences between total Reliability and Customer satisfaction in People's Bank services.

Table 7: T-test for Reliability and Customer satisfaction in private agents

	N	Mean	S.D	t-value	Sig.
Reliability	45	17.66	1.62	64.246	.000
Customer satisfaction	45	47.06	1.62	171.22	.000

The above table shows that Reliability t- value 64.246, Customer satisfaction t-value 171.22, sig. value is less than 0.05. Hence, it can be said that there is significant differences between Reliability and Customer satisfaction in Private agencies. Thus, the hypothesis can be accepted.

H₃: There is a relationship between customers - employee's relationship and customer's satisfaction

Table 8: T-test for Customer employee Relationship and Customer satisfaction in People's Bank services

	N	Mean	S.D	t-value	Sig.
Customer employee Relationship	45	21.11	1.33	111.92	.000
Customer satisfaction	45	46.53	1.39	224.32	.000

According to the above table, Customer employee Relationship at t- value 111.92 customer satisfaction t-values 224.32, sig. value is less than 0.05. So, it can be said that there is significant differences between Customer employee Relationship and Customer satisfaction in People's Bank services

Table 9: T-test for Customer employee Relationship and Customer satisfaction in private agents

	N	Mean	S.D	t-value	Sig.
Customer employee Relationship	35	22.28	1.87	70.43	.000
Customer satisfaction	35	47.06	1.62	171.22	.000

The above table illustrates, Customer employee Relationship at t- value 70.43, customer satisfaction t-value 171.22, sig. value is less than 0.05. So, it can be said that there is significant

differences between Customer employee Relationship and Customer satisfaction in Private agencies.

H₄: Speedy process also has relationship with customer satisfaction

Table: 10 T-test for speedy process and Customer satisfaction in People's Bank

	N	Mean	S.D	t-value	Sig.
Speedy process	45	21.20	1.33	102.199	.000
Customer satisfaction	45	46.53	1.39	224.32	.000

The above table shows that speedy process at t- value 102.199, customer satisfaction t-value 224.32, sig. value is less than 0.05. So, it can be said that there is significant differences between speedy process and Customer satisfaction in People's Bank services.

Table : 11 T-test for speedy process and Customer satisfaction in private agents

	N	Mean	S.D	t value	Sig.
Speedy process	35	21.91	1.70	76.07	.000
Customer satisfaction	35	47.05	1.62	171.22	.000

The above study shows that speedy process at t- value 76.07, customer satisfaction t-value 171.22, sig. value is less than 0.05. Therefore, it can be said that there is significant differences between speedy process and Customer satisfaction in Private agencies.

On the basis of analysis, researcher tested the hypotheses as follows.

Table : 12 Hypotheses testing

Serial No	Hypothesis	Tools	Results
H₁	There is a positive relationship between Service quality and customer satisfaction	Correlation & Regression	Accepted
H₂	There is a relationship between reliability and customer satisfaction.	T-test	Accepted
H₃	There is a relationship between customers - employee's relationship and customer's satisfaction.	T-test	Accepted
H₄	Speedy process also has relationship with customer satisfaction	T-test	Accepted

CONCLUSIONS AND RECOMMENDATIONS

According to the data analysis, relationship between customer satisfaction positively related with service quality ($r=0.556$ in People's Bank, $r=0.611$ in Private agencies). When comparing People's Bank and private agents, the relationship between customer satisfaction and service quality is higher in private agents ($r=0.611$). According to the regression value ($r^2=0.309$) between customer satisfaction and service quality, 31% of the impact on the service quality is attributed by the customer satisfaction. The regression linear model predicts the function with the constant value. Finally, the results supported the H₁, it explained there is a positive relationship between Service quality and customer satisfaction.

The t-value with the reliability and customer satisfaction predicted significant relationship between the independent and dependent variables. Employees' relations and speedy process also have a significant impact on customer satisfaction. According to the t- test, the values produced the conclusion on relationship between independent and dependent variables. Thus, the following

H₂, H₃, H₄ were accepted. It means, there is a relationship between reliability and customer satisfaction. There is a relationship between customers - employee's relationship and customer's satisfaction. Speedy process also significantly related with customer satisfaction.

This research study concluded that there is a positive relationship between customer satisfaction and service quality in Western Union money transfer. It was found Reliability, customer employee relationship and speedy processes have impact on the customer satisfaction in both services at people's banks and private agencies. The money transfer services obtained in people's bank branches have become important, because of credibility established with the People's bank as a state bank.

To improve the level of customers' satisfaction, the following recommendations are suggested below for both public and private agencies.

- The waiting time of customers should be reduced.
- The People's Bank and Private agents have to act quickly to respond customer's requests and reform its services to fulfill the needs of the customers.
- They can improve the online services and create awareness about online access among regular customers.
- The services can be extended over the many service points particularly in People's Bank branches.
- The state banks can focus the element Credibility of services among their customers to increase the customers' accessibility towards banks.

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EXPLORING HUMAN RESOURCE MANAGEMENT PRACTICES IN SRI LANKAN SMALL AND MEDIUM ENTERPRISES

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INTRODUCTION

Small and Medium Scale Enterprises (SMEs) make up a large part of Sri Lanka's economy, accounting for 80 per cent of all businesses. These are found in all sectors of the economy, primary, secondary and tertiary and provide employment for persons of different skills, skilled, semi-skilled and unskilled. There are SMEs in the agri-business sector engaged in growing spices, fruits and vegetables and in the manufacturing sector engaged in numerous industrial activities accounting for about 20 percent of industrial establishments. In the service sector SMEs accounts for more than 90 percent of business establishments. SMEs are an essential source of employment opportunities and are estimated to contribute about 35 percent of employment. The SMEs play an important role in promoting inclusive growth. The focus on SMEs in policy discussions emanates also from their role in developing entrepreneurial skills, innovation and promoting economic growth.

Increasingly, Small and Medium Enterprises (SMEs) are seen to have an important role in the Sri Lankan economy. Indeed, it would seem that both national and local economies are largely constituted of smaller enterprises, with the addition of a minority of larger enterprises. A number of problems emerge when assuming that small firms are the same as large firms. Welsh and White (1981) suggest that a traditional assumption amongst managers has been that small businesses should be managed along essentially the same principles as large businesses but on a smaller scale. They highlight the assumption that underlies this particular brand of thinking: those small companies are much like large companies, except they have smaller sales, less employees and smaller assets.

There is the need for HRM research on SMEs which are viewed as bedrock of economic development in many countries of which Sri Lanka is of no exception. Chandler and McEvoy (2000) suggest that although published research indicates that effective management of HR is one of the most important problems faced by SMEs, there is an acute shortage of research identifying the practices in use in small firms. This study examines the use and effectiveness of HRM practices within SMEs in Sri Lanka.

Human Resource Management practices and SMEs

Storey (1992) defines human resource management as a distinctive approach to employment management, which seeks to achieve competitive advantage through the strategic deployment of a highly committed and capable workforce, using an integrated array of cultural, structural and personnel techniques. Store's definition assumes that it is employees that give a competitive edge and that they should not aim at mere compliance with rules but that employees should be carefully selected and developed to ensure commitment. In order to ensure that employees are committed and capable there is a need to implement good HR practices to enhance goal attainment. Unfortunately, research on HRM practices has focused on large organizations which

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appear to suggest that HR issues are not important in small organizations. If we agree with scholars such as Armstrong (1999) that human resources are the most valuable assets or a key resource in any organization, then attention has to be paid to HR practices irrespective of the size of the organization and that organizations in trying to survive in a volatile environment must focus on the human resources that has the biggest potential to ensure organizational survival. Audretsch and Thurik (2000, 2001) argue that effective HRMP are becoming increasingly important in the modern “knowledge-based” economy, as companies face the double challenge of the need for more highly trained employees coupled with the shortage of qualified labour. These challenges, coupled with the third trend toward smaller firms in general, reinforce the need for effective HRM practices in the small firm.

Empirical research confirms that in general, smaller firms make less use of professional HRM practices than larger firms (Barron, Black and Loewenstein 1987; Hornsby and Kuratko, 1990). For example, smaller firms make less use of formalized recruitment practices (Aldrich and Langton, 1997), provide less training to their employees (Koch and McGrath, 1996; Westhead and Storey, 1999) and are less likely to use formalized performance appraisals (Jackson, Schuler and Rivero, 1989). In spite of the size effect, a growing base of research evidence suggests that far from being homogeneous, small firms nevertheless vary widely in the professional HRM practices in use (De Kok and Uhlaner, 2001). Deshpande and Golhar (1994) found HRM practices within many small manufacturing firms to be as sophisticated as those in larger companies. Similarly, Hornsby and Kuratko (1990) find that while firms of all sizes use primarily informal recruitment and selection techniques (mainly employee referrals and the interview), even among small firms, HRM practices are often more sophisticated than they had expected.

Research Problem

Given the review outlined above, the research aimed to address the following questions:

- What are the major HRM issues reported by managers in Sri Lanka SMEs?
- What HRM practices are used in Sri Lankan SMEs?
- How effective are these HRM practices seen to be?

Objectives of the research

The purpose of this study is to explore the Human Resource Management Practices (HRMP) in SMEs in Sri Lanka. The result of this study would help the SMEs to understand the significance of the HRMP and consider effective HRMP in order to induce and maintain success and survival of the organizations.

METHODOLOGY

Questionnaire was the tool to collect the data. The questionnaire survey was used to obtain primary data. The questionnaire was issued to the Admin officers or owners of the selected SMEs. A document review was carried out to obtain secondary data from the SMEs who participated in the study. The research originally planned to study SMEs in all districts (25) in Sri Lanka but the researcher could collect data only from 20 districts. Data could not be collected from 05 out of 25 districts because the researcher could not find a research assistant and because of the time factor. A total of 58 SMEs responded from the 20 districts. The study collected responses from 58 SMEs. They were mainly involved (53.4 %) in manufacturing (bakery, shoe, plastic, bag, frame, handloom, rubber, cushion work, milk, packet, poultry, water filter clay, sweet, tea estate) and 46.6% were service organizations (beauty parlour, printing, restaurant, hotels, shipping, construction). SMEs from 20 districts responded except five districts (Batticalo, Hambantota, Mannar, Mullitivu and Polonnaruva). In each district three SMEs responded except

Anuradhapura and Kalutura. 82.8% of the businesses are small and remaining 17.2 % are medium. Quantitative and qualitative analysis were conducted.

RESULTS AND DISCUSSION

Profile of the SMEs

In most SMEs (43.1%) the owner's age is more than 50 years. Most of the owners (94.8%) are male. 22.4% of the owners have experience in SME between 5 to 10 years. About 50% of the businesses were established in the last 10 years time. 50% of the owners commenced their business with G.C.E A/L qualifications. On average, they have 23 employees. 50% of the enterprises capital is between Rs.100000 to Rs.1000000.

HRM issues in Sri Lankan SMEs

73.6% of the SMEs responded that labour turnover is high. Poor employee (74.7%) attitude towards work has been hampering the performance of the SMEs. They (69%) are not committed to the work. They (60%) see the work as belonging to somebody. They (61.3%) do not regard the rules and regulations at the work place. The employees, the study revealed, are demanding more salary and other benefits than their output. Whether the SMEs are making it big or not the employees want their portion without delay. On the part of the employees they were of the view that the pay that they receive hardly takes them through to the next pay day due to the cost of living in the country. The current operations of most of the SMES were labour intensive. Some of the SMEs especially the medium sized ones complain of the inability of the applicant to handle basic tools and equipment. The use of ICT was also lacking in most of the employees. Most of the small enterprises complained of lack of trainees. Their trainees are usually school drop outs and people who could not gain access to higher education due to inability or lack of funds. The study established poor human resource practices (lack of HRP, motivation, training, knowledge) because issues of HR have not been placed at the core of the SMEs.

HRMP in Sri Lankan SMEs

SMEs had a relatively low level of HRM sophistication and application. Most (96.6%) of the SMEs had no HR department, Most (94.7%) of the SMEs had no HR specialist expertise, they (84.5%) made use of these HRM practices for running business, and they rated the effectiveness of their use of the professional HRM practices as less than large organization. 81% of the respondents responded that they practice staffing, training, compensation, human resource planning and performance appraisal but not in a professional manner and not formally. The survey findings demonstrated that firm size does have a significant impact on adoption of HRM practices. Small-sized firms had a significantly lower adoption rate of HRM practices than medium-sized firms. The table 1.1 shows the result of the HRM practices in SME.

Table 1.1 HRM Practices in SME

Description	Responses in Percentage	
	Yes	No
Practice HRM	84.5	15.5
Practice (Human Resource Planning, Recruitment and Selection, Training & development, Compensation, Performance Appraisal)	81	19
HR Department	3.4	96.6
HR Specialist or Expert	5.3	94.7

Source: Survey data 2013

The following discussions elaborate on HRM practices individually based on the firm size.

Recruitment and Selection

In small size enterprises the owner carries out the recruitment and selection. They prefer to recruit already trained employees rather than giving training after recruitment. Recruitment and selection in medium enterprises is more formalized than in small enterprises. Vacancies are declared through advertisements in the media and also in the operational area of the enterprises. Most of the respondents (84.5%) said that recruitment and selection is done by the owner. 24.1% respondents responded that interviews are used for selection of a candidate. Depending on the position to be filled qualifications (81% responded that basic qualification is required) and/or skilled training as well as previous experience are required. Retention strategies are based on performance of the employees. 91.4% respondents responded that they do not have staff for looking after recruitment and selection. 50% of the organizations practices promotion on the basis of performance and experience

Training and Development

In small and medium size enterprises, training is usually on the job conducted mainly by seniors and monitored by the owner. This study also confirms the previous findings which is that 98.3% provides on the job training. 10.3% responded that they provide off the job training too. They (19%) conduct training need assessment before training. There are little opportunities for external training for employees. 29.3% of the organization send the employees to external training organizations. The owners attend external training organized by their respective associations. On the job training is carried out by supervisors on periodic basis and some employees are also sponsored to participate in training programmes outside the enterprises. There is less chance for career development in SMEs compared to large organization. Further, employees feel that they do not have career opportunities for their development. They (72.4%) provide orientation training programme to the staff who join the organization. They (85%) conduct the training for 1 to 7 days. There is little training and development opportunities in SMEs

Table 1.2 Training and Development in SMEs

Description	Responses in Percentages	
	Yes	No
On the Job training	98.3	1.7
Off the Job training	10.3	89.7
Training Need Assessment	19.0	81.0
External Training	29.3	70.7
Orientation (formal & informal)	72.4	27.6
Orientation days (1 to 7)	85.0	15.0
Opportunities for T &D	14.5	85.5
Opportunities for new skills		

Source: Survey data 2013

Compensation

The SMEs responded that compensation is paid based on performance (50%) and competitive (50%). They (60%) responded that they pay incentives to their employees. The incentives are financial and non financial. They (60%) felt that incentives motivated their employees. They (55%) provide additional financial benefits too. 51.7% of the SMEs responded that employees have a career path.

When we are comparing small size enterprises with medium size there are some deviation in practicing compensation. In small size enterprises, compensation is not standard or not equal to market rate but medium size enterprises pay compensation equal to the market rate. Organizations also face difficulties finding suitable staff with knowledge and skills because compensation is not matched with their qualifications and market rate. Some small enterprises do not pay EPF and ETF. They pay salary daily and weekly not monthly.

Performance Appraisal

In SMEs (84.5%) responded that there is no formalized appraisal system. They use observation (44.8%), interview (32.8%) and questionnaire method (6.9%) to apprise the employees. In small and medium enterprises, performance appraisal is carried out on a monthly basis and is the responsibility (79.3%) of the owner and manager. It is discovered using the output of the employee/training and the deviations provides instant training to all the workers. It was discovered that there were no standardized appraisal forms. When the report is very bad the organization uses it as a basis to terminate the worker's appointment but in some cases the organization gives a second chance by providing extra coaching to the employees. 79.3% responded that there is an ineffective performance appraisal system.

Effectiveness of HRM practices

Medium size enterprise respondents indicated relatively moderate use of all areas of HRM practice. HRM practices and effectiveness of were all positive and correlated. Most of the small business holders have not heard of or understood these practices so they could not express the effectiveness of HRM practices.

CONCLUSIONS/RECOMMENDATIONS

The study provides insights into human resource practices and issues of SMEs in Sri Lanka. It was clear from the findings that SMEs face a lot of human resource challenges notable among them are poor attitude to work by employees, high demand for benefits, inability to attract and retain trainees and employees. The findings of the research would add to the literature on HRM in small and medium firms which appears to be non-existent in Sri Lanka. The managerial implication for the study is that owners/managers of SMEs should ensure good practices in HR in order to remain competitive. Performance of SMEs will therefore be enhanced if more attention is paid to the acquisition and management of human resources. SMEs owners and managers should broaden the scope of HR practices. It will increase the retention rate of employees, enhance the competencies and commitment of the work force and levitate the level of satisfaction among employees. This shift in turn enhances the organizational performance in terms of quality, productivity and market share. Successful HR system also helps to integrate the other organizational functions in lesser time.

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**THE IMPACT OF WORKING CAPITAL MANAGEMENT ON CASH HOLDINGS
(A QUANTITATIVE STUDY OF LISTED MANUFACTURING COMPANIES IN
SRI LANKA)**

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INTRODUCTION

Firms maintain a certain percentage of assets as cash but many firms have increased their cash holdings levels. Ferreira & Vilela (2004) investigated European Monetary union corporations' cash to assets ratio and showed that corporations holds 15% of their total assets in cash or cash equivalents. Bates et al (2006) report that the average cash to assets ratio for US industrial increased 129% from 1980 to 2004 and argue that change in cash holdings is not the result of recent build-up but a "secular trend". They used several variables to explore the motivation of US firms for corporate cash holdings and find that in order of importance, the change in net working capital of cash is the most important one. In Sri Lanka many companies still underestimate the importance of working capital management as a level for freeing up cash from inventory, accounts receivable and accounts payable. By effectively managing components, companies can sharply reduce their dependence on outside funding and can use the released cash for further investments or acquisitions. This will not only lead to more financial fertility but also create value and have a strong impact on a company's enterprise value by reducing capital employed and thus increasing asset productivity. The most important positions for effective working capital management are inventory, accounts receivable, and accounts payable. Depending on the industry and business, prepayments received from customers and prepayments paid to suppliers may also play an important role in the company's cash flow.

Problem Statement of the Study

Working capital is the most crucial factor for maintaining liquidity, survival, solvency and profitability of business. (Mukhopadhyay, 2004). Working Capital Management is one of the most important areas for making the liquidity and profitability comparison among firms, (Eljelly, 2004), involving the decision of the amount and composition of current assets and the financing of these assets. Shin and Soenen (1998) argued that efficient working capital management is very important to create value for the shareholders while Smith et al (2007) emphasized that profitability and liquidity are the salient goals of working capital management. Keeping in view the realistic importance of working capital management on cash holdings, an attempt is made to examine the impact of working capital management on cash holdings of the listed manufacturing companies in Sri Lanka. Despite the immense and increasing importance of listed manufacturing companies in Sri Lankan and their prevailing financial problems. Therefore the research question of the study is.

How does working Capital Management impact on cash holdings of the Sri Lankan Manufacturing Companies?

Objective of the study

To analyse the impact of working capital management on the level of cash held by Sri Lankan manufacturing listed companies.

Literature

Working Capital also known as net working capital is calculated as current assets minus current liabilities. The major components of working capital are accounts receivable, inventories, cash

and cash equivalents and payable. Almeida et al (2004) states the working capital affects the cash holdings. Besides the changes in short-term debt could be a substitute for cash because firms may use short-term debt as financial resource. Shin & Soenen (1998) point out that the more efficient the firm is in managing its working capital, the less the requirements for external financing and better financial performance.

Previous and recent studies of corporate cash holdings have explained working capital management. However further researching on this topic and more supportive explanations are desirable. In this paper, the main objective is to explore the relationship between working capital management and corporate cash holdings, and to investigate the interaction between them, how working capital management and corporate cash holdings affect each other of the Sri Lankan manufacturing Organizations.

Hypothesis I

H₀₁ : Cash holdings are negatively related to the presence of cash substitutes, i.e., negatively related to the level working capital, net of cash.

H_{01a} : Cash holdings are negatively related to the level of inventory (INV)

H_{01b} : Cash holdings are negatively related to the level of account receivable (A/R)

H_{01c} : Cash holdings are positively related to the level of short-term liabilities (STL)

The sub hypotheses ought to give a more detailed insight into the issue in order to differentiate between the components of working capital. This will allow finding out which of these components has the strongest influence on cash level.

Hypothesis II

H₂: Cash holdings are positively related to working capital management efficiency, i.e is negatively related to the cash conversion cycle (CCC)

H_{2a}: Cash holdings are negatively related to Days inventories outstanding (DSI)

H_{2b}: Cash holdings are negatively related to days sales outstanding (DSO)

H_{2c}: Cash holdings are positively related to days payables outstanding (DPO)

The three subordinate hypotheses which contain the components of the cash conversion cycle ought to provide a more detailed insight into the effect of the cash conversion cycle on cash holdings. Once again a differentiation will allow detecting the impact of the individual components of cash conversion cycle.

METHODOLOGY

In the Colombo Stock Exchange there are 288 Companies are listed from that in the Manufacturing sector all 37 companies are considered for this research for the period of 2008 to 2012. The researcher used quantitative descriptive methods. In this study, the cash to assets ratio is the dependent variable. The aim of the empirical part of this paper is to analyze the independent variables. i.e. working Capital net of cash ratio and the cash conversion cycle, including their subordinate components, on the dependent variable. The empirical results have been achieved by two kinds of statistical methods, namely univariate and bivariate analysis. This decision is based on the fact that the methods that have been employed present simple but significant tools in order to describe and analyze statistical relationships between the independent variables and the dependent variable.

RESULTS AND DISCUSSION

Univariate results

The following table 1 illustrates the results of a univariate analysis, namely the comparison of means. The independent variables' means have been calculated for each quartile of the dependent variables' mean. The 1st quartile therefore features companies which hold very low cash levels with cash to assets ratios spanning from 0 to 0.0123 and a mean of 0.0036 while the 4th quartile exhibits manufacturing companies with very considerable cash holdings with an average of 0.4025 and a range of 0.2313 to 0.9370. The independent variables including subordinate components are listed below.

Table 1 Comparison of Means

	1 st quartile	2 nd quartile	3 rd quartile	4 th quartile
Cash	0.0036	0.0433	0.1512	0.4025
Minimum	0.0000	0.0123	0.0853	0.2313
Maximum	0.0123	0.0852	0.2313	0.9370
NWC	0.0734	0.0640	0.0352	-0.0346
INV	0.2791	0.2462	0.1937	0.1357
A/R	0.2626	0.2621	0.2503	0.2021
ATL	0.4684	0.4442	0.4088	0.3724
CCC	74.83	68.14	61.05	53.13
DSI	59.56	51.7	41.55	34.14
DSO	49.54	48.05	46.44	40.72
DPO	34.27	31.62	26.93	21.73

Source: Survey Data

It can be observed that manufacturing companies with rather low cash holdings exhibit a considerable amount of inventory and accounts receivable but also rather significant short-term liabilities. The 4th quartile which contains manufacturing companies with very high cash levels features a negative net working capital, i.e. the short-term liabilities out balance the sum of inventory and accounts receivable. While an apparent steady negative relation exists between all three components of net working capital, the impact of inventory seems to be the most significant one, decreasing by nearly 50% from the 1st to the 4th quartile. The decrease in accounts receivable is clearly weaker with only roughly 23% from the 1st to the 4th quartile. Short-term liabilities also show a constant negative development with increasing cash levels. However, since they only decrease by ca. 20%, the impact on Net Working Capital (NWC) is not strong enough to hinder the overall negative relationship between net working capital and cash level which amounts to a total decrease of 0.108 points.

Bivariate results

The following illustration depicts a correlation table 2 which includes all variables. The Pearson correlation coefficient has been calculated for any possible pair of variables and a two-tailed test of significance has been applied. The results indicate that all but two results are significant at the 0.01 level. The statistically significant correlation coefficients are highlighted with an asterisk.

Table 2 Correlation table (*=significant at the 0.01 level)

	Cash	NWC	INV	A/R	STL	CCC	DSI	DSO	DPO
Cash	1								
NWC	(-0.208*)	1							
INV	-0.327*	0.499*	1						
A/R	-0.205*	0.221*	-0.042	1					
STL	-0.180*	-0.501*	0.225*	0.436*	1				
CCC	(-0.212*)	0.541*	0.507*	0.062*	-0.127*	1			
DSI	-0.235*	0.409*	0.747*	-0.282*	-0.044*	0.754*	1		
DSO	-0.152*	0.188*	-0.198*	0.632*	0.093*	0.393*	0.074*	1	
DPO	-0.218*	-0.009	0.196*	0.125*	0.249*	0.015	0.368*	0.336*	1

Source: Survey Data

The correlation of -0.208 indicates that there is a negative correlation between cash holdings and net working capital. However, due to the relatively low absolute value, it has to be assumed that this correlation is rather weak. The components of net working capital are all negatively related to

cash holding as the correlation coefficients suggest. Among the subordinate variables, the correlation between inventory and cash is the strongest with a coefficient of -0.327 although it is also a rather low absolute value. The relationship between cash conversion cycle and cash holdings is negative as the correlation coefficient of -0.235. The variable 'DSO' presents a rather weak correlation while 'DPO' is a bit stronger negatively related to cash holdings. First of all, there is a considerable positive correlation between 'NWC' and 'CCC' with a value of 0.541. Also, a significant positive correlation exists between 'INV' and 'DSI' as well as 'A/R' and 'DSO'.

HYPOTHESIS 1

Hypothesis 1 predicted that cash holdings are negatively affected by the presence of cash substitutes, i.e. negatively related to the variable 'NWC'. The univariate analysis of this study's sample clearly indicates that a firm's 'NWC' decreases with increasing cash level since a clear negative development of 'NWC' can be observed in the four quartiles. The bivariate analysis confirms this observation as the correlation coefficient for the variables 'Cash' and 'NWC' is negative. Therefore, the first major hypothesis can be confirmed. There is a negative relationship between cash holdings and the presence of cash substitutes.

The subordinate hypotheses were developed in order to give a more detailed insight into the issue. In this respect, Hypothesis _{1a} can be confirmed as the level of inventory has an unambiguously negative impact on cash levels, according to both the univariate and bivariate analyses. Hypothesis _{1b} can also be confirmed because there is statistically significant evidence that cash holdings are negatively related to accounts receivable. Hypothesis _{1c} however needs to be rejected because the univariate as well as the bivariate analysis suggest that there is not a positive but a negative correlation between cash level and short-term liabilities.

Hypothesis 2

Hypothesis 2 stated that cash holdings should be positively related to working capital management efficiency which again is measured by the cash conversion cycle. The variable 'CCC' thus was assumed to be negatively related to the variable 'Cash'. The comparison of means reveals that there is a steady negative development of the cash conversion cycle from the first to the fourth quartile. The bivariate analysis substantiates this finding by measuring a negative correlation coefficient. These results imply that cash level is positively related to working capital management efficiency and therefore the second major hypothesis can be confirmed.

Hypothesis _{2a} which ought to measure the impact of days sales of inventory can be confirmed since there is an apparent negative relationship between 'DSI' and 'Cash' which is backed by both the univariate and bivariate analyses. A negative correlation has also been calculated between days sales outstanding and cash holdings. Therefore, Hypothesis _{2b} can be confirmed, as well. Hypothesis _{2c} needs to be rejected as there is a clear negative relationship between cash level and days payable outstanding.

Recapitulation of hypothesis results

The following table3 recapitulates the hypotheses, their proposition and their result, i.e. whether empirical evidence led to their confirmation or rejection.

Table 3

Hypothesis	Proposition	Result
H01	Cash holdings are negatively related to the presence of cash substitutes, i.e. negatively related to the level of working capital net cash	confirmed
H01a	Cash holdings are negatively related to the level of inventory	confirmed
H01b	Cash holdings are negatively related to the level of accounts receivable	confirmed
H01c	Cash holdings are positively related to the level of short-term liabilities	rejected
H2	Cash holdings are positively related to working capital management efficiency, i.e. negatively related to the cash conversion cycle.	confirmed
H2 a	Cash holdings are negatively related to DSI	confirmed
H2b	Cash holdings are negatively related to DSO	confirmed
H2c	Cash holdings are positively related to DPO	rejected

There is explicit empirical evidence which supports the decisions on the above described confirmations and rejections of hypotheses. All in all, the two major hypotheses can be confirmed although one hypothesis subordinate to each of these respectively has been rejected. The two hypotheses which have been rejected both deal with the liabilities side of working capital but their impact is apparently not strong enough to obviate the confirmation of the two major hypotheses.

CONCLUSION /RECOMMENDATIONS

There is Negative relationship between cash holding and both net Working Capital and the cash conversion Cycle. Accounts receivable also seen to bear an overall negative relationship with cash holdings. There are substitutes, i.e. inventory, accounts receivable and short-term liabilities, as well as the way in which working capital is managed, represented by the cash conversion cycle.

Therefore, the researcher has given strong recommendations once the target cash level has been determined, the management of working capital ought to be adjusted in order to adhere to the predetermined level of cash holdings and it is important to monitor both aspects in order to detect the combined policy which leads to optimal results for the achievement and maintenance of the target cash level.

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UTILIZATION OF POLYETHYLENE SCRAPS IN RUBBER FORMULATION TECHNOLOGY FOR MANUFACTURE OF LOW COST RUBBER PRODUCTS

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INTRODUCTION

Sri Lanka is one of the nine major producers of Natural Rubber (NR) in the world. In terms of productivity, it is now the third best. Presently, Sri Lanka produces about 150,880 metric tons of rubber annually, exporting about 20% - 30%. The value of Sri Lanka's rubber industry exports has been growing steadily. If Sri Lanka is to retain and improve its position in the fast expanding and increasingly competitive global rubber business in the next years, it has to adopt new technologies and practices, keeping in mind economical usage of valuable natural resources. In spite of impressive progress in the Sri Lankan rubber industry, there are still a lot of possibilities for optimization of rubber formulation technologies in order to use natural rubber economically and bring down high production cost. One of the ways to achieve this goal is usage of large quantities of non-reinforcing fillers such as calcium carbonate (CaCO₃) and China clay which are widely distributed in Sri Lanka. These fillers act as diluents, and when added in large quantities in order to reduce cost, they usually produce a negative effect on strength characteristics of rubber compounds such as tensile, abrasion resistance, impact and tear resistance. One of the possible reasons for deterioration could be attributed to reduction of polymeric content that seems to be insufficient to bind dispersed fine filler particles and form continuous polymer-filler matrix. In order to overcome this problem it was proposed to use low density polyethylene (LDPE) scraps to increase polymeric content in rubber compounds heavily loaded with mineral fillers. Polyethylene waste, mostly partially degraded after being exposed to prolonged sun radiation represents a large part of plastic environmental pollution in Sri Lanka. Such LDPE scraps melt at comparatively low temperature, that could be easily achieved during compounding and still be safe for rubber. LDPE melts being compatible with natural and synthetic rubber extend polymeric content allowing the compound to absorb increased amounts of inert filler. LDPE is not a new material for rubber compounder. It is used, for an example, with EPDM rubber to improve dielectrical properties of rubber compounds (1). It was reported, that LDPE-natural rubber blend threaded with poly-(methyl methacrylate) modified water hyacinth fiber gave a high value of tensile strength, Young's modulus, glass transition temperature and melting temperature (2). LDPE is used in dynamically vulcanized elastomers to improve impact resistance and stiffness (3). Even in practice experienced mixer operators charge the banbury with some chemicals being packed in polyethylene bags. They do not remove packaging as it dissolves in rubber compounds during mixing. In spite of this the data on application of LDPE scraps in low cost compounds have not been published in commonly available literature and the present study would be interesting for rubber compounders as well as for researches in the related fields.

METHODOLOGY

Natural rubber under Technically Specified Rubber (TSR) of SLR- 20 grade was purchased from Yatideriya Rubber Factory, Undugoda, managed by Associated Specialty Rubber Private Limited, Sri Lanka. Commercial grade chemicals were bought from the local market. They included: LDPE recycled material gray grade, locally produced calcium carbonate of Lakcarb Calcite 0001 grade, silica granules of Mansil commercial brand, silane coupling agent, stearic acid, paraffin wax, zinc oxide, accelerators, sulfur and others. Six rubber compounds were

prepared as per formulations given in Table 1. All compounds were filled with calcium carbonate. They differed by concentration of LDPE that varied from 0 pphr to 90 pphr.

Table1. Rubber compound formulations

Formulation	F-0	F-20	F-25	F-30	F-40	F-90
Ingredients	pphr	pphr	pphr	pphr	pphr	pphr
SLR-20	100	100	100	100	100	100
LDPE	0	20	25	30	40	90
Fillers - Silica	40	40	40	40	40	40
PG	4	4	4	4	4	4
Silane coupling	4	4	4	4	4	4
Stearic acid	2	2	2	2	2	2
Parafine wax	1	1	1	1	1	1
Zinc oxide	5	5	5	5	5	5
CCO ₃	100	100	100	100	100	100
CBS accelerator	2	2	2	2	2	2
Sulphur	3.5	3.5	3.5	3.5	3.5	3.5
Total	261.5	281.5	286.5	291.5	301.5	351.5

It should be noted, that all formulations were made free of antioxidants, as compounds were not planned to be stored for a long period of time. All rubber compounds were prepared using a laboratory scale internal dispersive mixer. Compounding of master batch was done in two stages .On completing 24 hour's maturation, the 2-nd stage master compound was sulfured in an open two roll mill. Rheological properties of prepared compounds were determined with oscillating disc rheometer "Monsanto" R100 at temperature of 180°C. Rubber samples for testing physical and mechanical properties were cured in compression moulds fixed to the platens of a laboratory type "MOORE" hydraulic press preheated to 150 °C along with plates. After de-molding and cooling, the specimens were tested to determine tensile properties (ASTM D412), specific gravity (ASTM D297), hardness (ASTM D2240 00), rebound resilience (ASTM D2632) and abrasion resistance (ASTM D5963).

RESULTS AND DISCUSSION

Rheological curves were obtained for three samples taken out of each prepared rubber compounds. Rheological characteristics included minimum torque value T_{\min} and maximum torque value T_{\max} , scorch time t_{10} and optimum cure time t_{90} . (Table 2).

The observed maximum torque was influenced directly by the cross-linking density. But, for LDPE that was not participating in chemical bonds formation its influence on maximum torque was relatively low with some reduction due to dilution of compound resulting in reduction of total cross linking density. The scorch time corresponding to 10% curing (t_{10}) increased with increasing in LDPE content in composition. This fact is very important for rubber processor as a safety period of compound usage was improved. Optimum cure time corresponding to 90% curing (t_{90}) was decreased initially due to reduced viscosity and better mobility of rubber chains and further proportionally increased with increasing plastic content. Mechanical and Physical properties of experimented rubber compounds are given in table 3.

Table 2. Rheological characteristics

N	Formulas	t_{10}	t_{90}	T_{\max}	T_{\min}
1	F-00	1.04	1.52	88.78	3.50
2	F-20	1.02	1.50	88.00	3.77
3	F-25	1.20	1.62	86.00	3.80
4	F-30	1.28	1.66	85.99	4.00
5	F-40	1.44	2.00	85.16	4.50
6	F-90	1.60	2.30	75.10	6.20

Table 3. Properties of rubber compounds

Formulation	F-0	F-20	F-25	F-30	F-40	F-90
LDPE content , pphr	0	20	25	30	40	90
Tensile strength, MPa	10.5	11	10	7.5	7	4.98
300% Modulus,	8.99	10	9.0	8.5	7	4.98

(MPa)						
100% Modulus, (MPa)	7	7.8	6.61	6.0	5.5	4.0
Elongation at break ,%	533	394	291	380	402	410
Hardness, (Shore A)	82.3	86.2	89.3	88.6	88.7	92.5
Specific gravity,g/cm ³	1.362	1.359	1.329	1.324	1.311	1.221
Rebound resilience,%	42	40	41	36	34	30
Abrasion loss,mm ³	180	175	185	188	190	220

Tensile strength, elasticity modulus at 100% elongation and elasticity modulus at 300% showed highest values for the composition containing 20 pphr of LDPE. This indicates that presence of LDPE in the amount of 20 pphr promoted reinforcement of natural rubber with calcium carbonate filler. The reason for this could be associated with better distribution of filler and curatives throughout the highly filled rubber matrix. Elongation at break reduced with increasing LDPE content and achieved minimum level of 291% when concentration of LDPE in composition was 25 pphr. This behavior could be explained by restriction of mobility of rubber molecules due to formation of additional physical and chemical bonds between rubber and filler. Further addition of LDPE to rubber compound improved its flexibility, as hard filler was diluted with polymeric matrix. The incorporation of LDPE caused an increase of compound hardness value. For LDPE Shore D hardness is 55 and after converting to the hardness in scale A, this value comes to 95, while for natural rubber Shore A hardness is 55 only. This fact is very important, as it gives a good opportunity for rubber producers to raise compound hardness keeping its specific gravity at low level. With addition of LDPE rebound resilience decreased. This property is dependent mainly on elasticity of the base polymer in compound. The elasticity of natural rubber is better, when compared to other synthetic rubbers and general use plastics. It is obvious that incorporation of plastic dropped down rebound resilience and it should be noted that this drop was not significant until LDPE content did not exceed 20 pphr.

It is well known that chemical cross links do not favor abrasion resistance, while physical bonds introduced by reinforcing fillers are of mobile nature, so they allow more creep and dissipate frictional energy. As LDPE facilitated physical reinforcement of rubber with mineral fillers some improvement in abrasion resistance was observed, however when LDPE amount exceeded 20 pphr abraded material loss increased, because no additional physical cross-links were formed.

CONCLUSIONS/RECOMMENDATIONS.

The above research was carried out to guide local rubber producers in development of cost effective natural rubber based formulation technology with utilization of LDPE scraps.

The major conclusions that can be drawn from the research carried out are:

1. It is possible to mix LDPE scraps with natural rubber compounds in commonly used internal rubber mixing machines.
2. Addition of LDPE to rubber compounds improved green strength of unvulcanized rubber.
3. With introduction of LDPE the safety period of sulphured compounds can be extended.
4. It is possible to increase compound hardness keeping specific gravity of compound at a low level.
5. With respect to the mechanical properties of vulcanized rubber compounds, the concentration of LDPE in rubber compounds should not exceed 20 pphr in order to achieve some improvement in tensile strength and abrasion resistance as further increment of LDPE content would lead to deterioration of those properties.

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UTILIZATION OF THERMALLY SYNTHESIZED NaCoO_2 IN CATHODES OF SODIUM-ION RECHARGEABLE BATTERIES

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INTRODUCTION

It is found that 1.4 billion people live without access to electricity out of which 67% live in Asia (World Energy Issues, 2012). The storage of energy is another dimension in the energy problem. Where electrical energy storage batteries are concerned, research on lithium and sodium-ion rechargeable batteries started in the early 1980s. Comparatively the lithium ion rechargeable battery was chosen to be developed first because of its higher energy density (Kim *et al.*, 2006). The cost concern of lithium metal caused sodium metal to be looked at again for rechargeable batteries (Terasaki, 2003; Shin, et al., 2002). Research and development aspect of sodium-ion batteries are now on the move globally. At present the challenge for materials design exist in the field of sodium-ion batteries, and in the past couple of years, several reports on new sodium-ion technologies and electrode materials have emerged. They range from new layered oxides, polyanion-based materials, carbons and other insertion materials for sodium-ion batteries, many of which hold the promise for future sodium-based energy storage applications. As sodium resided lower to the Li in reactive series, the size suffers when it resides in the cathode material structure.

This study utilizes sodium cobalt oxide as the cathode material of sodium ion rechargeable batteries due to its remarkable physical and chemical properties. But in previous studies this material has been synthesized to be used in lithium ion rechargeable batteries. Therefore, NaCoO_2 is synthesized, characterized and utilized in sodium ion rechargeable batteries to evaluate its characteristics and performance.

METHODOLOGY

Polycrystalline samples of NaCoO_2 were prepared by solid-state reaction where, starting materials, sodium carbonate (Na_2CO_3) and cobalt(II) oxide (CoO) were mixed in appropriate molar ratio (De Silva and Perera, 2013). Thermal Gravimetric (TG) analysis was carried out to find the exact range of temperature that the solid-state reaction takes place.

The mixtures were further sintered at 700 °C for 12 hours. X-ray diffraction (XRD) characterization was performed on the resulting powder with Bruker D8 Focus X-ray Diffractometer using Cu K_α radiation and scanning electron micrographs (SEM) were taken to analyze the structure of the sample.

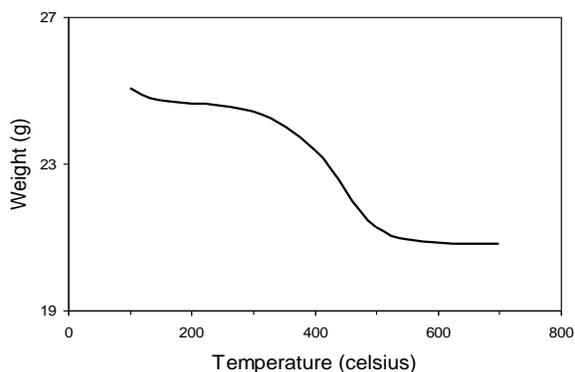
The synthesized NaCoO_2 powder was then used as the cathode material in sodium-ion batteries and devices were fabricated as follows. A slurry was first made by grinding NaCoO_2 85% with 5% acetylene black (AB) and 10% polyvinylidene fluoride (PVDF) as the binder dissolved in 1-methyl-2-pyrrolidinone (NMP) and cast on a stainless steel plate. Then it was allowed to slow dry at 120 °C on a hot plate. The half cell of the battery was constructed in N_2 atmosphere with sodium foil as the anode. A polyester membrane was placed in between the cathode and anode as the separator that soaked with the electrolyte, where the electrolyte is 1M solution of NaClO_4 in

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propylene carbonate. In charge discharge tests the cell was discharged at a rate of 0.75 mA/mg until it reached a voltage of 0.1V.

RESULTS AND DISCUSSION

Figure 1 shows the variations of weight of the reactants, Na_2CO_3 and CoO_2 with temperature in the synthesis of NaCoO_2 . The observation shows a dramatic loss of weight of the NaCoO_2 sample in-between $350\text{ }^\circ\text{C}$ to $455\text{ }^\circ\text{C}$ and average stability after $455\text{ }^\circ\text{C}$ as the temperature increases. A slight drop of weight can also be observed at the very beginning due to removal of moisture from the reactants. The cause of the intense weight loss in between the regions of $250\text{ }^\circ\text{C}$ to $450\text{ }^\circ\text{C}$ reported due to dissociation of Na_2CO_3 evolving CO_2 . Therefore effective formation of NaCoO_2 polycrystalline begins at the temperature range in-between $350\text{ }^\circ\text{C}$ to $455\text{ }^\circ\text{C}$. However, the initial reaction rate seems to be low as evident from the gradient of the curve just after $350\text{ }^\circ\text{C}$ which



becomes steeper after $400\text{ }^\circ\text{C}$.

Figure 1 : Variations of weight of the reactants, Na_2CO_3 and CoO_2 with temperature in the synthesis of NaCoO_2

The XRD characterization assured the correct formation of the crystalline structure of the cathode material. XRD patterns of the NaCoO_2 sample is shown in figure 2. The amount of sodium affects the structure of the sodium cobalt oxide as observed in the final product. Comparison of the peaks of the XRD pattern of the samples with the standards, confirmed that the synthesis route leads to formation of the NaCoO_2 as the active material.

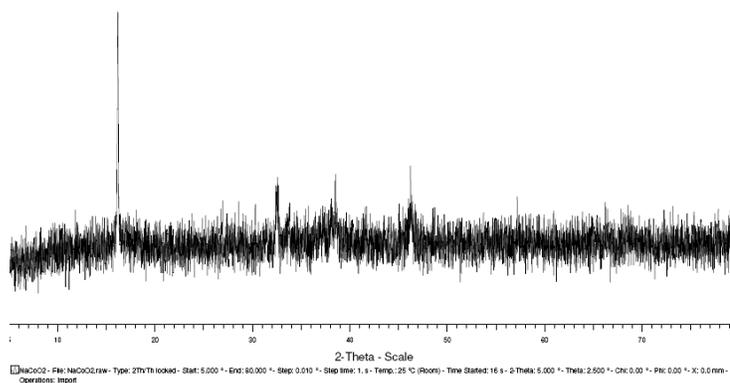


Figure 2 : XRD pattern of NaCoO_2

The apparent XRD peaks of the sample observed for 2θ values at 16, 33, 38 and 46 degrees where h, k, l values obtained at the range of $-7 < h, k < 7, -40 < l < 40$ by Yasuhiko, 2002, *et al.* matched with the standard confirming the proper synthesis of sodium cobalt oxide which is the active cathode material of the secondary sodium-ion battery. The crystal size of the sodium cobalt oxide was about 42 nm calculated using the Scherrer's equation for the peak appeared at 16 degrees in the XRD.

The lattice structure of NaCoO_2 consists of two separated CoO_2 layers per unit cell and sodium layer located in between them as shown in figure 3.b (Takada *et al.*, 2003). This structure strongly depends on the sodium content and is not well defined. Each cobalt oxide layer forms an edge-sharing CoO_6 octahedral network.

This crystalline structure is similar to that of high- T_c cuprate superconductors, except that in each layer Co atoms form a triangular (hexagonal) lattice rather than a square lattice. In a crystal having sodium content of $x = 0.7$ the lattice constants (distances between ions) are equal to $a = 2.75 \text{ \AA}$ and $c = 10.85 \text{ \AA}$ (Takada *et al.*, 2003).

Physical properties of the substance in the context of particle size, crystal arrangement and shape could further be seen by a scanning electron micrograph of the sample (figure 3a). The result thus clearly indicates the difficulty of obtaining NaCoO_2 in nanometer scale with desired morphologies under the traditional high temperature solid-state process (Kumar Rai, *et al.*, 2013). The porous structure of the film enables the insertion of sodium ions in charge discharge process.

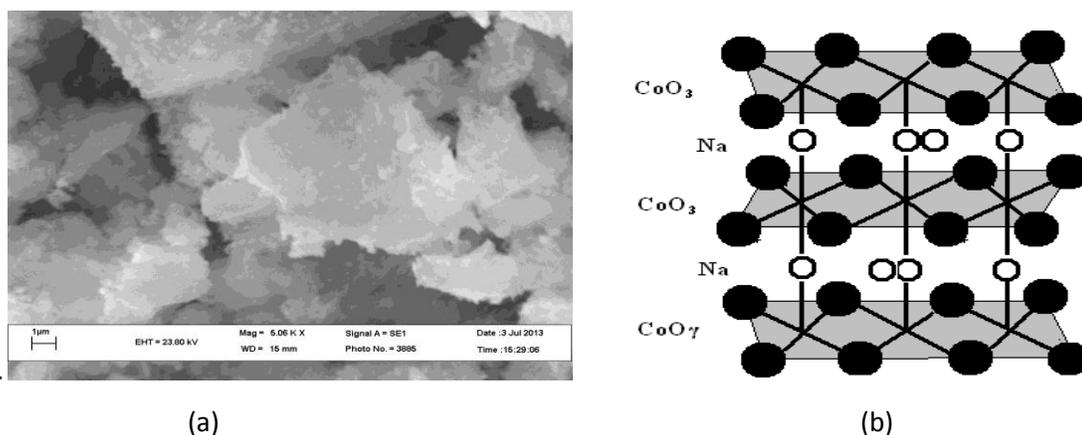


Figure 3 (a) Scanning electron microscopic (SEM) image of NaCoO_2 sample (b) Schematic view of NaCoO_2 structure.

The charge/discharge is another cyclic method to study the capacity of a rechargeable battery. By this method the amount of charge which could be retained with time could be calculated. The cell was discharged at a rate of 0.75 mA/mg until it was reached to a voltage of 0.1V. The retained capacity value was then calculated to be 40 mAh/g.

The insert in figure 4 demonstrated more than ten charge/discharge cycles which kept until it reach the flatter level at each cycle and the stability was monitored. The cell reported a voltage of 2.6 V initially and at no-load level again it reached a value just more than 2.3 V after undergoing eleven charge discharge cycles. These patterns confirmed the stability of the cells developed in this study.

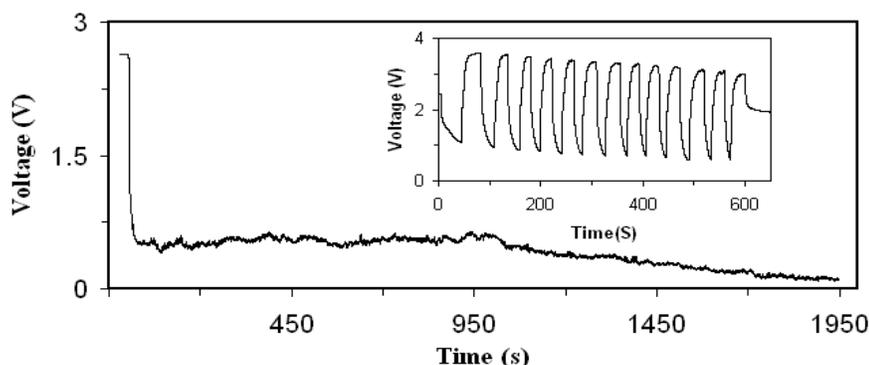


Figure 4: First discharge in the cell made of NaCoO_2 . Insertion is for ten charge discharge cycles of the same cell.

CONCLUSION

Revealing the best charge retention of NaCoO_2 cathode material from our earlier studies, the effective range of temperature for solid state reaction was observed in between $350\text{ }^\circ\text{C}$ to $455\text{ }^\circ\text{C}$. The Hexagonal structure of porous crystalline was justified by characterization with XRD and SEM. The capacity of the cell tested with charge-discharge cycles found to be 40 mAh/g . Considering all these facts it can be recommended that NaCoO_2 is a potential cathode material for the secondary sodium-ion battery.

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COPPER IODIDE AS THE HOLE TRANSPORT LAYER IN BULK HETEROJUNCTION ORGANIC PHOTOVOLTAICS

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INTRODUCTION

Polymer solar cells undoubtedly hold tremendous potential for solution-processable, inexpensive photovoltaics on flexible plastic substrates (Shaheen *et al.*, 2005). The most promising organic photovoltaics (OPVs) are based on random dispersion of acceptors in the form of organic or inorganic nanostructures within a conjugated polymer matrix, which acts as the donor phase. The interfaces at the acceptor nanostructures and the donor host polymer matrix create bulk heterojunctions (BHJs), which provide a large number of sites for charge separation and continuous pathways for efficient carrier transportation (Duren *et al.*, 2004). Although numerous combinations of acceptors and donors have been reported, the most popular BHJ polymer solar cells consist of poly(3-hexylthiophene) (P3HT) and fullerene derivative phenyl-C61-butyric acid methyl ester (PCBM) blends. The mechanisms for achieving high photovoltaic efficiencies in excess of 6% in P3HT:PCBM BHJ devices are well established (Ma *et al.*, 2005). However, several key components remain unresolved and must be addressed if the theoretical efficiency of 10% is to be reached (Dennler *et al.*, 2009). For example, in a simple BHJ device, both the donor and acceptor phases are in direct electrical contact with the cathode and anode electrodes, leading to recombination of charge carriers and current leakage. To minimize such detrimental effects, electron blocking and hole transport layers (HTLs) are deposited on top of the transparent and conducting tin oxide (CTO) anode. HTLs must be wide band gap p-type materials, and several inorganic materials such as V_2O_5 and MoO_3 (Shrotriya *et al.*, 2006) have been reported with NiO being the most effective, attaining efficiencies greater than 5% (Irwin *et al.*, 2008). However, inorganic HTLs are deposited using vacuum deposition techniques that are incompatible with the advantages of solution-processable and printable electronics of OPVs. Thus, the most commonly employed HTL in polymer solar cells is semiconducting poly 3,4-ethylene dioxythiophene: polystyrene sulfonic acid (PEDOT:PSS) between the ITO anode and the active layer. PEDOT:PSS has the advantages that it is deposited from solution and serves to minimize the detrimental effects of CTO roughness as well as to align the work functions of P3HT and CTO for more efficient collection of holes. However, PEDOT:PSS is usually deposited from highly acidic (\sim pH 1) aqueous suspensions that are known to corrode CTO at elevated temperatures (Kim *et al.*, 2006) and can also introduce water into the active layer, degrading the device performance (Lagemaat *et al.*, 2006). Our research is motivated by the need to overcome the limitations of PEDOT:PSS as the HTL by finding a suitable solution-processable alternative that is compatible with OPV materials and fabrication techniques. Therefore this research attempted to find out solution-processable HTL materials purely soluble in organic solvents to mitigate the inclusion of water into the active layer which occur with the use of PEDOT:PSS.

Copper Iodide (CuI) is an inorganic p-type high band gap hole conducting material. In fact it is easily soluble in organic solvents such as acetonitrile. Moreover, the hole mobility of CuI is quite high and band positions fit well with the HOMO and LUMO levels of the active materials (P3HT:PCBM) of the OPV for efficient transport of holes to the CTO. Further it has been reported to be used as hole transport materials in dye sensitized solid state solar cells as well. Thus in this work we report the use of thin films of CuI as HTL in OPVs which minimize the back electron transfer enhancing the efficiency of the cell.

METHODOLOGY

Conducting tin oxide (CTO) glass plates were used as the substrates for the deposition of active materials after cleaning by sonication in propenol for 15 minutes. 50 mg of CuI dissolved in 2 ml of acetonitrile was used to deposit the HTL on these substrates by spin coating at 2500 rpm. To prepare the active layer, 20 mg of P3HT and 15 mg of PCBM were dissolved in 1 ml of chlorobenzene by stirring for 3 hours. Then the active layer, P3HT:PCBM of thickness around 200 nm – 400 nm was deposited by following the same technique. The films were kept on a hot plate at 80 °C for 5 minutes. Silver paste was applied on the top of the P3HT:PCBM layer to make the back contact.

The organic polymer materials used were characterized by UV-Visible spectroscopy. The BHJ OPVs were characterized by I-V and impedance spectroscopic measurements.

RESULTS AND DISCUSSION

Figure 1 shows the UV-visible spectra of (a) P3HT (b) PCBM and (c) P3HT:PCBM blend in chlorobenzene that used to deposit the active layer of the organic photovoltaic cells. As it is evident from the figure the polymeric material, P3HT is solely responsible for the absorption of light in the visible region. The polymeric material, PCBM only absorb light in the ultraviolet region. Thus OPVs become active for both the UV and visible light by combining the two materials together.

Figure 1 UV-Visible spectra of (a) P3HT (b) PCBM and (c) P3HT:PCBM blend

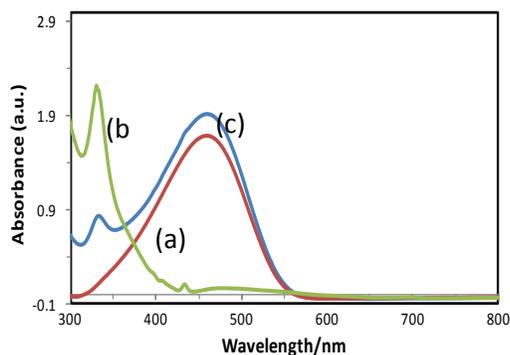


Figure 2 illustrate the heterostructure CTO/CuI/P3HT:PCBM/Ag of the OPV. In order to compare the photo response of the above device structure, the heterostructure of CTO/PEDOT:PSS/P3HT:PCBM/Ag was also fabricated with spin coating PEDOT:PSS under the same condition which used to deposit CuI layer.

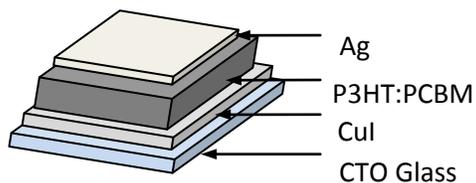


Figure 2: Schematic diagram of a heterostructure of CTO/CuI/P3HT:PCBM/Ag of the OPV I-V characteristic curves of the BHJ solar cells of the structures (a) CTO/CuI/P3HT:PCBM/Ag and (b) CTO/PEDOT:PSS/P3HT:PCBM/Ag are depicted in figure 3. The cell parameters such as short circuit photocurrent (J_{sc}), open circuit photovoltage (V_{oc}), fill factor (FF) and efficiency (η) are given in Table 1 that measured under the illumination of 100 mWcm^{-2} for comparison.

The efficiency of the CTO/CuI/P3HT:PCBM/Ag cell is around 0.1% which is not significant compared to the current records of BHJ solar cells with PEDOT:PSS as hole transport layer. However, the higher photovoltage of the cell assures that the band structure of CuI is well matched with the other organic semiconductors for efficient transfer of electrons and holes. The low photocurrent of this cell may be due to the low work function of silver paste where aluminum is the back contact normally for BHJ solar cells which is deposited by physical vapour deposition.

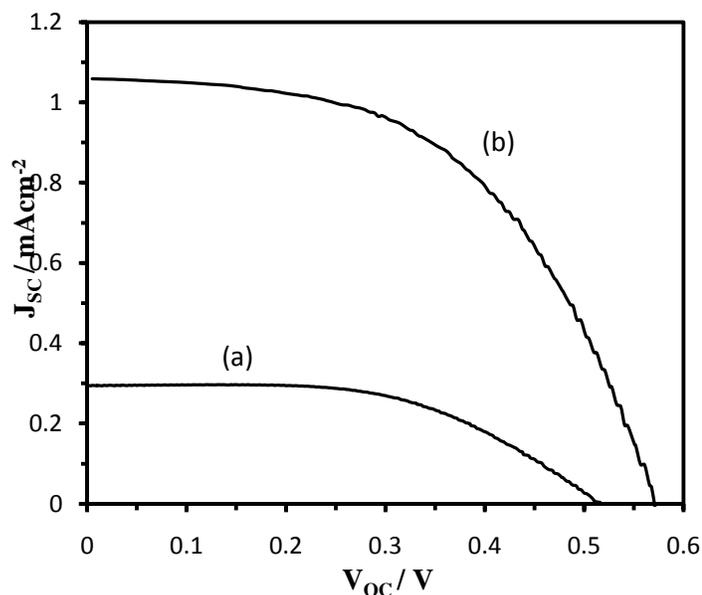


Figure 3: I-V characteristic curves of the BHJ solar cells (a) CTO/CuI/P3HT:PCBM/Ag and (b) CTO/ PEDOT:PSS /P3HT:PCBM/Ag.

Table 1: Cell parameters of CTO/CuI/P3HT:PCBM/Ag and CTO/PEDOT:PSS/P3HT:PCBM/Ag BHJ solar cells measured under 100 mWcm^{-2} illumination.

Heterostructure of the Device	Jsc (mAcm^{-2})	Voc (V)	FF %	$\eta\%$
CTO/CuI/P3HT:PCBM/Ag	0.295	0.516	54	0.08
CTO/PEDOT:PSS/P3HT:PCBM/Ag	1.058	0.568	53	0.31

Impedance spectroscopy (IS) is used to study the dielectric properties of a medium as a function of frequency. Therefore the frequency response of the system reveals the electrical energy storage and dissipation properties where the data obtained by IS are expressed graphically in Nyquist plot.

Equivalent circuit could be modeled for such an impedance spectra and resistance and capacitance values of the circuit components of the system can be found out by analysis. Figure 4 shows the impedance curves for the heterostructures CTO/CuI/P3HT:PCBM/Ag and CTO/PEDOT:PSS/P3HT:PCBM/Ag. It is clear from the Nyquist plots that the CuI based heterostructure has a high parallel resistance ($4500 \text{ k}\Omega$) than the PEDOT:PSS based cell ($12 \text{ }\Omega$). This may be also a reason for the low photocurrent of the CuI based OPV. But it is possible to dope CuI films to gain high conductivities with I_2 and other elements which may improve the cell performance.

CONCLUSIONS/RECOMMENDATIONS

A possible bulk heterojunction OPV was developed using CuI as the hole transport layer. Since the fabrication was done solely by solution processable technique using non-aqueous solvents, the stability of the device needs to be tested for any improvement. The performance of this cell is inferior to the current BHJ OPVs developed with PEDOT:PSS hole transport layer due to several reasons. The reasons are non usage of expensive vacuum deposited aluminium back contact and the high parallel resistance of the OPV based on CuI which could be overcome by doping the CuI layer.

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IMPEDANCE SPECTROSCOPIC ANALYSIS OF POLY ANILINE FILMS FOR PHOTOVOLTAIC APPLICATIONS

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INTRODUCTION

All the energy consumed by humans in an entire year is less than the energy from the sun which strikes the earth in 1 hour (Lewis, 2007). Therefore, solar energy conversion is a highly attractive route for clean and renewable power for the future. During the past decades, photovoltaic cells have attracted much attention. Organic Photovoltaics (OPV) as low cost alternatives to conventional inorganic photovoltaic devices, are getting enormous attention today because of their flexibility, light weight and solution processability (O'Regan, Gratzel, 1991; Hagfeldt, Gratzel, 1995). Organic solar cell devices are fabricated using polymers such as Poly(3-hexylthiophene-2,5-diyl) (P3HT), poly(3,4-ethylenedioxythiophene) (PEDOT) and polyaniline (PANI), which play the role of p-type material as the hole conductor or electron donor. Among them, PANI is an excellent host for trapping semiconducting nanomaterials and conducts the electric charges through the polymeric chain due to extended π -electron conjugation (Sadia Ameen *et al.*, 2013). The conductivity of this polymer can be varied by doping them with different protonic acids and it is soluble in organic solvents, like toluene, xylene, chloroform and *m*-cresol (Cao *et al.*, 1992). Polyaniline has been the most widely studied material as a unique member of the conducting polymer family because its electrical properties can be reversibly controlled by both oxidation and protonation and it has high environmental stability and conductivity (Milind *et al.* 2006).

Electrochemical Impedance spectroscopy (EIS) is a powerful technique for the characterization of electronic or ionic transport processes of materials used in OPVs. In this paper, we report our work on characterization of polyaniline thin film prepared for OPV applications with Impedance Spectroscopy to calculate dielectric losses at room temperature.

METHODOLOGY

Chemical oxidative polymerisation of aniline to give the conducting emeraldine salt was carried out using ammonium persulphate as initiator in the presence of 1.5 M camphor sulphonic acid (CSA) at $\sim 4^\circ\text{C}$. The reaction was carried out for 4h. The green precipitate formed, which was the polyaniline doped camphor sulphonic acid (PANICAS) was filtered, washed with water followed by acetone. The samples were then dried in an oven at 60°C for 6h.

Polymer suspension for spin coating was made by dissolving PANICAS in *m*-cresol (20 mg ml^{-1}) and stirring the suspension for 2h. PANICAS film was coated on conducting tin oxide (CTO) glass plates ($12\ \Omega\ \text{cm}^{-2}$) by the following method. CTO glasses were cleaned well and Scotch tapes were stuck on one edge of the conducting glass to keep unexposed to the film to make electrical contacts in later stage. Polymer dispersion was spin coated on CTO glass plates at 2500 rpm for one minute to obtain the PANICAS films. These films were dried at 80°C on a hot plate for 10 minutes. Different thicknesses were obtained by repeated coatings. The thickness of the films was determined gravimetrically. Pt sputtered on CTO glass was pressed on the PANI film to make the electrical contact.

TiO₂ film of $\sim 10\ \mu\text{m}$ thick was deposited on conducting tin oxide glass by the following method. Titanium isopropoxide 5 ml was mixed with 5.5 ml of acetic acid. The mixture was diluted with

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10 ml of propan-2-ol and 5 ml of water was added drop wise keeping the solution vigorously stirred. Hydrolyzed titanium isopropoxide was mixed with 0.6 g of Degussa P-25 TiO₂ powder. A cleaned CTO glass plates cut into the size of 1 x 1.5 cm² was placed on a hot plate at 120 °C and the viscous TiO₂ past was spread on the conducting surface and sintered at 450 °C for 10 min. Coating and sintering process were repeated several times until a film of 10 μm is formed. TiO₂ film was dyed with Ru N3 dye. Dye coated TiO₂ films as well as the bare TiO₂ films were spin coated with PANICAS dissolved in *m*-cresol (20 mg ml⁻¹) and dried at 80 °C on a hot plate. Pt coated CTO glass was pressed on the films as previous to make the electrical contact.

Electrochemical impedance spectra of these films were measured with GW Instek LCR meter using the software provided with the instrument to couple with a computer, in the frequency range from 20 Hz to 1 MHz using an ac signal of 20 mV. The measured impedances and the phase angles of the films at different frequencies were used to draw Nyquist plots. The impedance spectra were used to characterize the films for their dielectric losses.

RESULTS AND DISCUSSION

Figure 1 shows the molecular structures of polyaniline and the camphor sulphonic acid and their interacting mechanism. Camphor sulphonic acid is used to dope polyaniline to increase its electrical conductivity. Sulphonic group in the dopant ionically interact with the electron lone pairs of nitrogen in the polymer chain to make it positively charged. This makes the polymer ionic conductive. There exist two types of ionic conductions in this type of highly doped polyaniline films. One is along the polymeric chain and the other is across the adjacent polymer chains which are termed as interchain and intrachain conduction respectively.

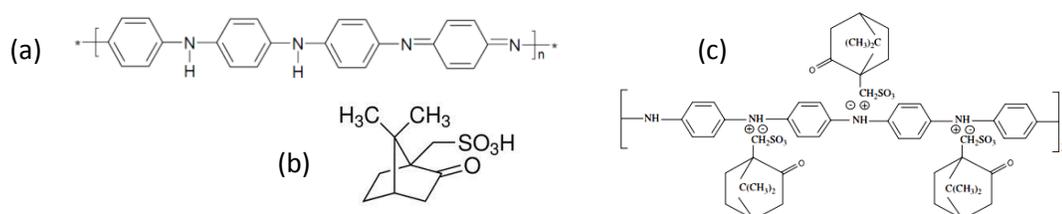


Figure 1: Molecular structures of (a) polyaniline and (b) Camphor sulphonic acid

Impedance spectroscopy (IS) measures the [dielectric](#) properties of a medium as a function of [frequency](#). It is based on the interaction of the dielectric medium with an external electric field that gives information on the [impedance](#) of a system over a range of frequencies. Therefore the frequency response of the system reveals the energy storage and dissipation properties where the data obtained by IS is expressed graphically in a [Bode plot](#) or in a [Nyquist plot](#). Figure 2 depicts the Nyquist plots of polyaniline films of different thicknesses deposited on CTO glass by spin coating technique.

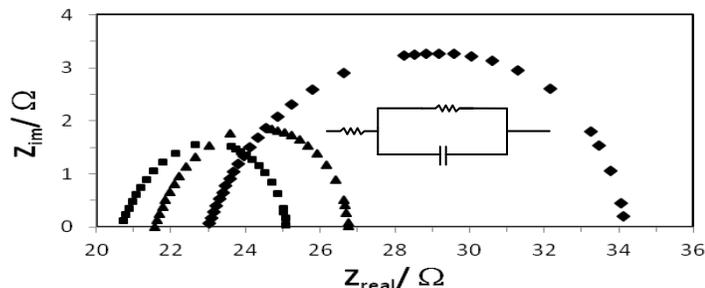


Figure 2: Nyquist plots of polyaniline films (a) 0.5 μm (b) 1 μm (c) 1.5 μm thicknesses. Insertion is the equivalent circuit for the polyaniline films

PANI film deposited on CTO glass model a cell where the contact resistance (R_1) in series with the parallel combination of capacitance (C) and resistance (R_2) of the film. Subsequently, it is possible to find the equivalent circuit and the significance of the different components. The given

Impedance Spectra were analyzed for resistance and capacitance values of the components of the equivalent circuit modeled in the insert of figure 2. They are given in table 1 for Nyquist plots of different thicknesses of the films depicted in figure 2.

Table 1: resistive and capacitive values of equivalent circuits

Film Thickness (μm)	R_1 ($\text{k}\Omega$)	R_2 ($\text{k}\Omega$)	C (μF)
0.5	23.1	11.0	7.0
1.0	21.5	05.2	5.8
1.5	20.7	04.4	5.2

It is evident from Table 1, that all the circuit parameters such as parallel and series resistances and capacitance of the equivalent circuits decrease when the film thickness increases. This behavior of the film can be explained by modeling the polymer chain arrangement in thin films and thick films as shown in figure 3. The polymer chains are arranged in parallel with the substrate in thin films but for thick films they have the freedom to arrange randomly. Therefore in thin films, interchain conduction is parallelly along the film and intrachain conduction is across the film which restrict the conduction mechanisms. But there is no such a limitation for thick films that both the interchain and intrachain conduction can contribute for conduction parallel and across the film. Therefore change of degree of freedom of conduction in the film results to lower R_1 and R_2 values when the film thickness increases. Decrement of capacitance of the film when the film thickness increase is understood by the inverse relationship of capacitance and the thickness of the film.

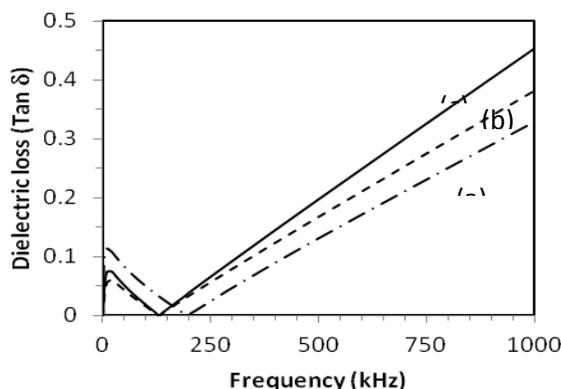


Figure 4: Dielectric loss of polyaniline films (a) 0.5 μm (b) 1 μm (c) 1.5 μm thick measured at different frequencies that deposited by spin coating on CTO glass.



Figure 3: Model illustrating PANI polymer chain arrangement in a (a) thin film (b) thick film

Dielectric loss quantifies the material's inherent dissipation of electromagnetic energy into heat. It can be represented by loss tangent, $\tan \delta$ which refers to the phasor in the complex plane of a Nyquist plot whose real and imaginary parts are the resistive and reactive counterpart. It is clear from figure 4 that the dielectric loss increase with the film thickness at high frequencies but decreases in the zero to 250 kHz frequency range. Dielectric loss occurs in PANI films due to ionic conduction at low frequencies and dipolar polarization at high frequencies. Both the ionic conduction and dipolar polarization in an a.c. field leads to dielectric relaxation. Dielectric

relaxation is the lag in ionic conduction or dipole orientation behind an alternating electric field. When the film is thin ionic conduction across the film occurs mainly by intrachain conduction. But for thick films ionic conduction across the film also occurs due to interchain conduction. Since the intrachain conductivity contributes to an increase in dielectric loss than the interchain conductivity, dielectric loss is higher in thin films. But at high frequencies bipolar polarization become prominent so that the dielectric loss increases with the film thickness.

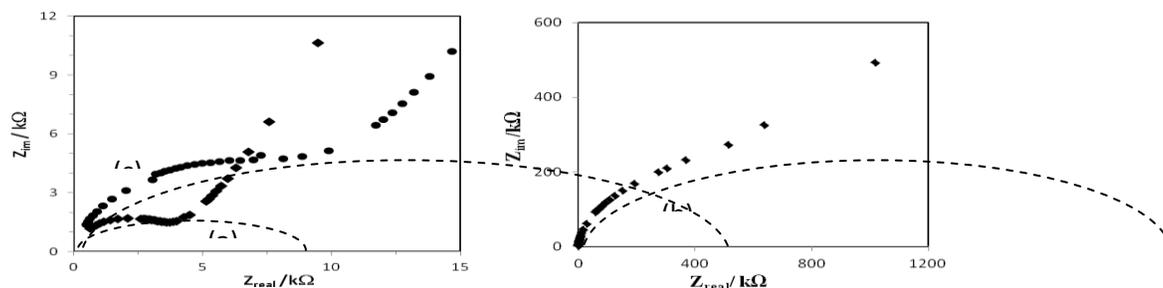


Figure 4 Nyquist plots of (a) TiO₂ film (b) Dye coated TiO₂ film (c) PANICAS film deposited on a dye coated TiO₂ film

A dye sensitized solid state solar cell (DSSC) of the hetero-structure TiO₂/Dye/PANICAS was constructed and impedance was measured by taking Nyquist plots for bare TiO₂ film, Dye coated TiO₂ film and PANICAS deposited TiO₂ film coated with the dye. It is clear from these plots that the resistance of TiO₂ film increases by more than two decades after coating the dye on the film and decrease again to the same order of magnitude by coating the PANICAS film on the dye coated TiO₂ film.

CONCLUSIONS/RECOMMENDATIONS

Poly aniline deposited on CTO glass can be represented by a simple configuration of single resistor in series with a RC transfer circuits in impedance spectroscopic measurements. The variation of impedance of films with different thicknesses and dielectric losses of the films can be explained by interchain and intrachain conduction of the films. Impedance of DSSC of the heterostructure TiO₂/Dye/PANICAS is of the same order of magnitude that as the impedance of bare TiO₂ film.

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INVESTIGATIONS ON SYNTHESIS OF $\text{Li}(\text{Ni}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3})\text{O}_2$ BY GLYCINE NITRATE COMBUSTION TECHNIQUE

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INTRODUCTION

As far as the world energy consumption is concerned, switching to new sources of energy such as wind power, tidal power, geothermal energy, solar cells, fuel cells and energy storing devices as batteries are important. The batteries are given a major importance due to its wide range of usage in almost all portable and house hold-devices, without which, perhaps, people cannot fulfill their necessities at present. From an overall perspective rechargeable Li-ion batteries undoubtedly represent the most promising energy storage system and certain aspects of its principles of operation deserve particular attention (Xu *et al.*, 2012). The performance of a battery is mainly related to the intrinsic property of the materials of the positive and negative electrodes and the electrolyte. LiCoO_2 has most widely been used. However, the high cost is a main obstacle for reaching it to the common mass as a cheaper and reliable material for potable power source (Whittingham, 2004).

$\text{Li}(\text{Ni}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3})\text{O}_2$ has recently been investigated as an alternative for cathode materials in secondary lithium ion batteries with better cycling performance and stability at high potential windows (Samarasingha *et al.*, 2008). It has been reported that the electrochemical performance of $\text{Li}(\text{Ni}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3})\text{O}_2$ is strongly affected by the synthesis condition due to the difference in homogeneity. However, its optimum synthesis conditions and material characteristics, especially electrical properties, have not been systematically investigated. By considering them, this work was based on investigation of synthesis and electrical conductivity of $\text{Li}(\text{Ni}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3})\text{O}_2$ material prepared by Glycine-Nitrate Combustion (GNC) methods (Wijayasingh, 2004), which is a low cost technique but can result in powders with high purity, homogeneity and particle morphology that are highly desired for Li-ion battery cathodes.

METHODOLOGY

$\text{Li}(\text{Ni}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3})\text{O}_2$ powder was synthesized by GNC method. Stoichiometric amount of metal nitrates, LiNO_3 , $\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$, $\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ and $\text{Mn}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ were mixed with distilled water. Glycine fuel was added to the nitrate solution and the new powder compositions were prepared with various glycine (G) to nitrate (N) ratios to investigate the effect of G:N ratio on the powder synthesis. The powder obtained after the combustion was ground and calcined at 1000°C for four hours. The phase analysis of powder was carried out with X-ray diffractometry (XRD, Siemens D5000 using monochromatic $\text{Cu K}\alpha$ radiation).

The calcined powders were uni-axially pressed at different pressure to find the optimum pressing condition to prepare solid pellets. Then the green pellet of 12 mm diameter and 0.5 mm length was prepared. After that the green pellets were subsequently sintered at 1000°C for 2 hours under

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air. The d.c. four probe electrical conductivity measurements of gold pasted pellets were performed on heating and cooling in the temperature range between room temperature (25°C) and 200 °C, keeping the specimens in a specially designed sample holder.

RESULTS AND DISCUSSION

The calcined powders were subjected to phase analysis by XRD. Figure 1 shows the x-ray diffractograms obtained on these powders prepared with different G:N ratios, calcinated at 10000C. In this figure, the corresponding diffraction pattern of the $\text{Li}(\text{Ni}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3})\text{O}_2$ base material is labeled as 333 (Samarasingha et al., 2008). Accordingly, the existence of the same R3m phase of \square - NaFeO_2 layered structure of $\text{Li}(\text{Ni}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3})\text{O}_2$ can be seen in all these materials prepared in this study with different G:N ratio.

Furthermore, as seen in Figure 1, this study shows the possibility of obtaining the appropriate $\text{Li}(\text{Ni}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3})\text{O}_2$ material even with a very low G:N ratio, such as 0.2. However, the higher G:N ratios have improved the structural behavior of the materials, by narrowing the peaks in the peak pattern as seen in Figure 1. Accordingly, the optimum G:N ratio of around 0.6 can be suggested from this study to synthesize these $\text{Li}(\text{Ni}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3})\text{O}_2$ powders by the GNC method.

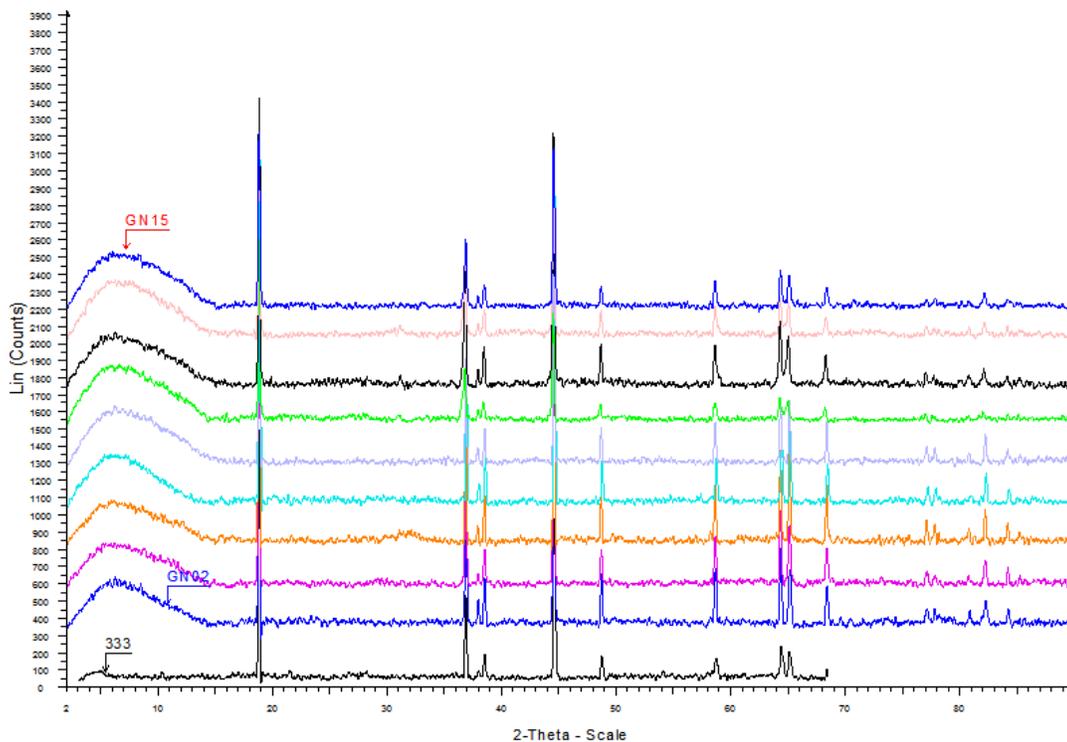


Figure 1: The X-ray diffractograms obtained on the $\text{Li}(\text{Ni}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3})\text{O}_2$ materials prepared with different G:N ratios. The corresponding diffraction pattern of the $\text{Li}(\text{Ni}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3})\text{O}_2$ base material is labeled as 333 (Samarasingha et al., 2008).

Figure 2 shows the variation of the pellet density (both green density and sintered density) with the pressing pressure. This study was performed to find the optimum pressing pressure in order to obtained dense pellets with highest possible sintered density, hence with lowest possible porosity in the solid pellets.

As seen in the figure, the green density (density before sintering) was continuously increasing with the pressing pressure. However, the behavior of the sintered density with pressure was

significantly different. With the increase of the pressing pressure, the sintered density increased to a maximum and further increase of the pressure has decreased the sintered density. Hence this indicated that an optimum pressing pressure around 250 MPa is necessary to obtain well sintered solid pellets with highest possible density.

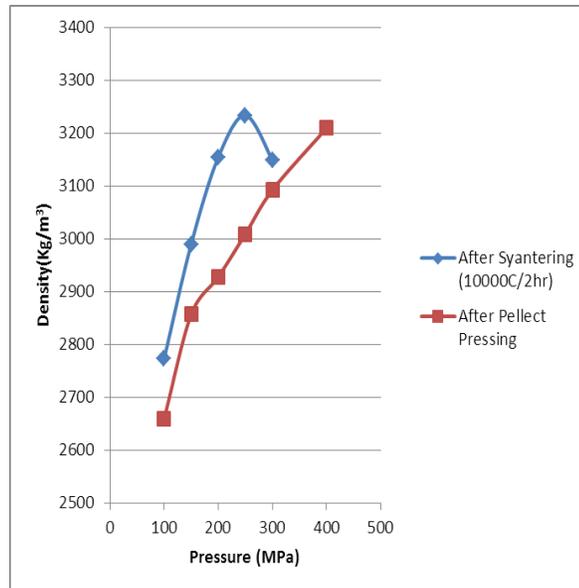


Figure 2: Variation of density with the pressure applied in uni-axial pressing of the pellets.

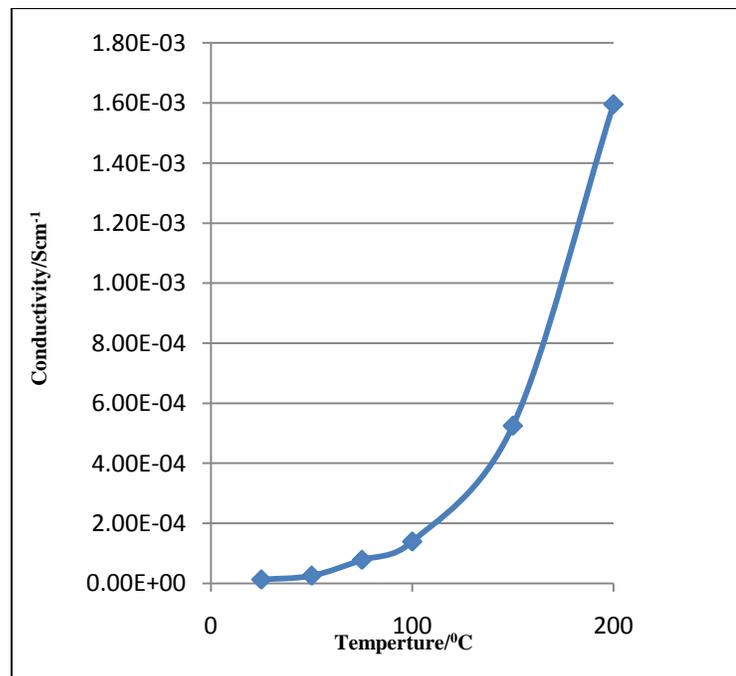


Figure 3: The variation of the DC electrical conductivity of $\text{Li}(\text{Ni}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3})\text{O}_2$ material with temperature.

As seen in Figure 3, the measured electrical conductivity of these materials increased exponentially with measuring temperature, indicating semiconductor behaviour in these materials

. The measured electrical conductivity of the material prepared with G:N = 0.5 shows a room temperature (25 °C) electrical conductivity of 1.25×10^{-5} S/cm, indicating a sufficient electrical conductivity for the intended application in LIB cathode.

Accordingly, this study reveals the possibility of synthesizing these materials by the glycine nitrate combustion technique with appropriate phase purity and electrical conductivity for the cathode application in the lithium ion rechargeable batteries.

CONCLUSIONS

The XRD phase analysis on the $\text{Li}(\text{Ni}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3})\text{O}_2$ materials prepared by the glycine nitrate combustion technique revealed the formation of only the appropriate layered R3m structure in all the prepared materials with different G:N ratios from 0.2 to 1.5. Higher G:N ratios can improve the structural behavior of the materials to an optimum ratio of 0.6.

According to this study, the optimum pressing pressure is 250MPa to obtain a dense solid material with the highest density. Further, the material prepared with G:N= 0.5 showed a considerable electrical conductivity of 1.25×10^{-5} S/cm at room temperature (25 °C) .

In conclusion, this study shows the possibility of preparing $\text{Li}(\text{Ni}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3})\text{O}_2$ materials by the glycine nitrate combustion technique with phase purity and electrical conductivity required for the cathodes of the rechargeable Li-ion batteries.

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**SYNTHESIS AND ELECTRICAL CHARACTERIZATION OF
LI (Ni_{1/3}Co_{1/3-x}Mn_{1/3}M_x)O₂, (M=FE, AL, MG, CU AND X=0.04, 0.08) FOR THE
CATHODE OF LI-ION RECHARGEABLE BATTERIES**

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INTRODUCTION

Energy can be stored in many forms, among which batteries are the most versatile energy storing method to be used in almost all portable devices, where a power source is required. When we consider popular rechargeable batteries, the Li-ion battery (LIB) has twice the specific energy compared to Ni metal hydride battery and four times that of Ni-Cd battery.

In searching for alternative cathode materials to replace the costly LiCoO₂ in LIB, the layer structured NMC compositions, which contains the transition metal elements of Ni, Mn and Co, such as Li (Ni_yCo_{1-2y}Mn_y)O₂ system has extensively been studied. Li(Ni_{1/3}Co_{1/3}Mn_{1/3})O₂ is an important member of this system (Whittingham, 2004). The electrochemical performances and safety of these materials are analogous or even superior to that of LiCoO₂ (Xu, 2012).

Further development of this Li (Ni_{1/3}Co_{1/3}Mn_{1/3})O₂ system by substituting Co by other cheaper metal oxides, Li(Ni_{1/3}Co_{1/3x}Mn_{1/3}M_x)O₂, (M=Fe, Al, Mg, Cu and x = 0.11, 0.22, 0.33), has recently been investigated by this group (Samarasingha, 2013). The outcome of it indicated the importance of studying the lower level substitutions (x < 0.11). Therefore this work was based on investigations of (Ni_{1/3}Co_{1/3x}Mn_{1/3}M_x)O₂ (M=Fe, Al, Mg, Cu and x= 0.04 and 0.08) synthesized by the Pechini method. This is a low cost synthesis technique but can result in powders with high purity, homogeneity and particle morphology (Wijayasinghe, 2006) that are greatly preferred for the rechargeable Li-ion battery cathodes.

METHODOLOGY

Li(Ni_{1/3}Co_{1/3x}Mn_{1/3}M_x)O₂, (M=Fe, Al, Mg, Cu and x= 0.04 and 0.08) powders were synthesized using Pechini method. In this, stoichiometric amount of metal Nitrates, LiNO₃, Ni(NO₃)₂.6H₂O, Co(NO₃)₂.6H₂O, Mn(NO₃)₂.4H₂O, Fe(NO₃)₃.9H₂O, Al(NO₃)₃.9H₂O, Mg(NO₃)₂.6H₂O, Cu(NO₃)₂.3H₂O of analysis grade were used as starting materials with the organic precursor solutions of citric acid (CA) and ethylene glycol (EG). Powders were prepared with the EG/CA ratio of 4:1, because the previous studies have proved that optimal gelling condition occur at this ratio (Samarasingha *et al.*, 2008). The mixture of nitrates, citric acid, and ethylene glycol was stirred for 20 hours and then heated while being stirred (Samarasingha *et al.*, 2013). The resultant powders were calcined at 900 °C in air in a box furnace. The phase analysis was carried out with X-ray diffractometry (XRD, Siemens D5000 using monochromatic Cu K α radiation). The calcined powders were pressed in to green pellets of 12 mm in diameter, followed by sintering at 1000 °C in a box furnace in static air. The d.c. electrical conductivity measurements were performed on gold pasted sintered pellets, on heating and cooling in the temperature range between room temperature (25°C) and 200°C.

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RESULTS AND DISCUSSION

The calcined powders were subjected to XRD phase analysis and Figure 1 shows the X-ray diffractograms obtained on these powders calcinated at 1000°C for four hours. As seen in the figure, all these materials show the peak pattern corresponding to the α -NaFeO₂ layered structure of R3m phase, indicating the formation of the appropriate Li(Ni_{1/3}Co_(1/3-x)Mn_{1/3}M_x)O₂ (M=Fe,Al,Mg,Cu) in all the materials investigated in this study.

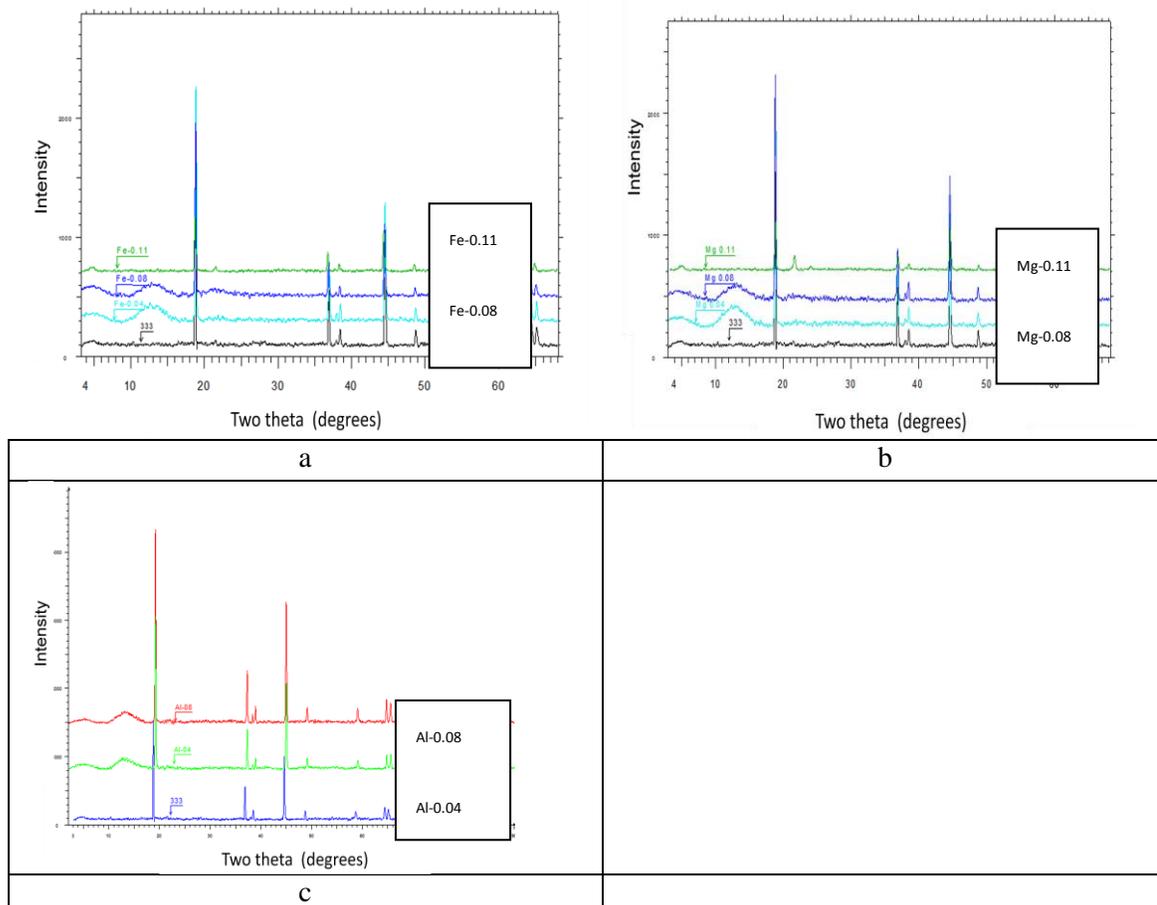


Figure 1: The X-ray diffratograms obtained on prepared Li (Ni_{1/3}Co_(1/3-x)Mn_{1/3}M_x)O₂ materials (a). Fe substituted materials (b). Al substituted materials (c). Mg substituted materials

Figure 2 shows the variation of the measured electrical conductivity with the temperature. As seen in the figure, the electrical conductivity of these materials increased exponentially with measured temperature, therefore, indicating a semiconductor behavior for these materials. Table 01 shows the corresponding room temperature (25 °C) electrical conductivity varies with the composition of the prepared materials

All of these materials (except 0.04 mole% of Mg substituted material) show comparable or even better electrical conductivity than that of the base material (Pushpaka Samarasingha *et al.*, 2013). Further, the Cu substituted materials, Li (Ni_{1/3}Co_{1/3-x}Mn_{1/3}Cu_x)O₂ (X=0.04, 0.08) show a

significantly increased conductivity. As a whole, this study reveals the possibility of synthesizing these materials by Pechini method with appropriate phase purity and considerable electrical conductivity for the LIB cathode application.

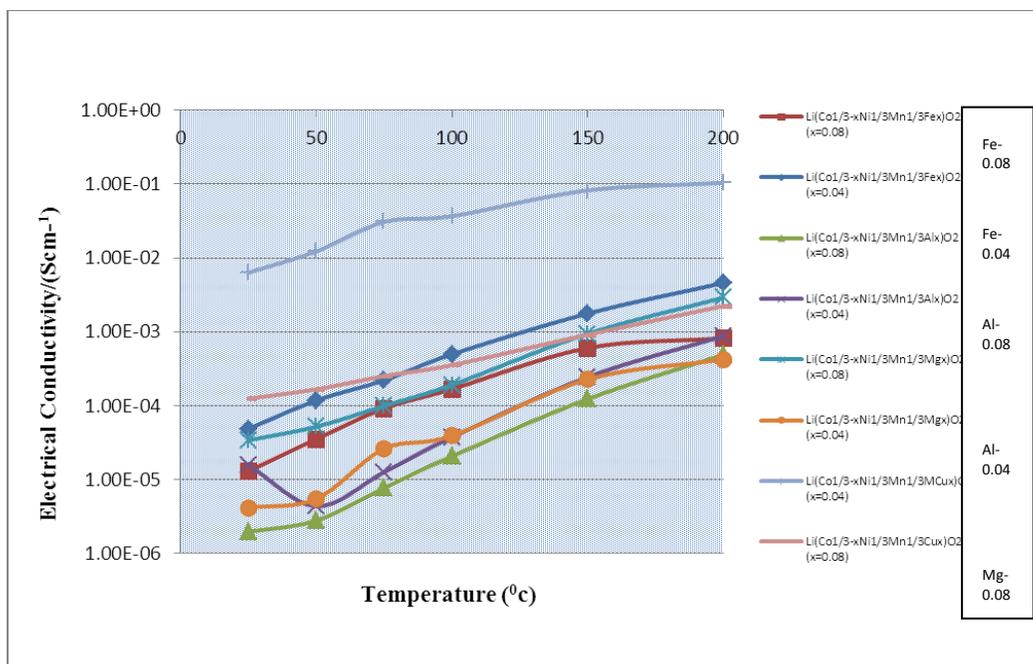


Figure 2: Variation of the d. c. electrical conductivity of synthesized powders with temperature.

Table 1: The d.c. electrical conductivity of synthesized powders at room temperature (25 °C)

Composition of synthesized powders	X (mole %)	DC electrical conductivity(S/cm) at room temperature (25 ^o C)
Li (Ni _{1/3} Co _(1/3-x) Mn _{1/3})O ₂ (The base material)	0.00	7.85 x 10 ⁻⁰⁵
Li (Ni _{1/3} Co _(1/3-x) Mn _{1/3} Fe _x)O ₂	0.08	1.31 x 10 ⁻⁰⁵
	0.04	4.88 x 10 ⁻⁰⁵
Li (Ni _{1/3} Co _(1/3-x) Mn _{1/3} Al _x)O ₂	0.08	1.98 x 10 ⁻⁰⁶
	0.04	1.58 x 10 ⁻⁰⁵
Li (Ni _{1/3} Co _(1/3-x) Mn _{1/3} Mg _x)O ₂	0.08	3.43 x 10 ⁻⁰⁵
	0.04	4.20 x 10 ⁻⁰⁶
Li (Ni _{1/3} Co _(1/3-x) Mn _{1/3} Cu _x)O ₂	0.08	1.26 x 10 ⁻⁰⁴
	0.04	6.36 x 10 ⁻⁰³

CONCLUSIONS

The XRD phase analysis performed on Li (Ni_{1/3}Co_(1/3-x)Mn_{1/3}M_x)O₂ (M=Fe,Al,Mg,Cu),(x=0.04,0.08) materials prepared by the Pechini method in this study, revealed the formation of only the appropriate layered R3m structure in all the synthesized and caicined at 900 °C.

The measured conductivity at 25 °C is varies according to the material composition. The Cu substituted materials show the highest electrical conductivity, which was $6.36 \times 10^{-03} \text{ Scm}^{-1}$ at room temperature. Accordingly, this study shows the possibility of synthesizing $\text{Li}(\text{Ni}_{1/3}\text{Co}_{(1/3-x)}\text{Mn}_{1/3}\text{M}_x)\text{O}_2$ (M=Fe,Al,Mg,Cu) materials by the Pechini method with appropriate phase purity and electrical conductivity for the LIB cathode application.

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A SURVEY ON TOOLS/SYSTEMS TO GENERATE DATABASE FROM FORM ANALYSIS

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INTRODUCTION

Globalization and rapid development of Information and Communication Technology (ICT) are major reasons to adapt ICT to businesses in the modern world, as it improves business competitiveness (Skoko *et al.*,2008). It has been shown that ICT helps to improve Small and Medium Enterprises' (SME) business performance too (Apulu and Latham,2009). Although SMEs are interested in adapting ICT, lack of ICT expertise and the system cost have been identified as major challenges (Harindranath *et al.*,2008). SMEs cannot develop their own ICT application either by outsourcing or purchasing off the shelf products, because it is costly. They might not have enough technical knowledge to develop their ICT application in house. Also, it is costly for them to maintain a separate ICT expertise group for this purpose (Harindranath *et al.*,2008).

Information systems (IS) play a major role in ICT applications and one of the most critical factors in any IS development is the database (DB) (Sanctum,2001). DBs need technical knowledge to develop, based on system requirements (Buchholz *et al.*,1995). Hence, it is a challenge to SMEs to develop a DB for their IS. Further, at the beginning of a software development project SMEs face difficult situations as they are not able to specify what they really need from an IS (Martínez and García-Serrano, 2001). Therefore, if there is a tool/system that helps to develop DBs in a user friendly manner and cost effective way, then non-technical people will be benefited and it would be affordable for SMEs a they could develop their own IS by themselves.

Consequently a method that helps to automate the DB design process by forms may solve the problem to some extent, as forms in businesses are widely used to gather, maintain and report the data requirements of the businesses. Manual forms as well as digital forms help to gather data and keep them in a structured way. Forms are familiar, easy to read and can be understood by any end users to communicate many requirements of the system. Therefore we can consider the forms as a vital input source for DB design process (Choobineh *et al.*,1988). It provides a common vocabulary and goals among end users and data processing professionals, rather than providing exhaustive requirements collection by end-users (Choobineh *et al.*,1992). Some research studies have been already carried out in order to automate the DB design process based on business forms. The purpose of this research is to study the appropriateness of form based analysis to DB design process for SMEs.

METHODOLOGY

A comprehensive literature search was done to find existing tools/systems and approaches that generate Database Diagram (DD)/Entity Relationship Diagram (ERD) automatically centered on form analysis. Two approaches were considered for literature survey, such as DB scheme creation

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from legacy system DB and forms, and DB scheme creation from new forms. Analysis was carried out based on the objective of the research. It is important to evaluate the tools/systems and approaches based on the quality of the outcomes, since their quality affects both the efficiency and the effectiveness of IS (Moody, 2005). Moody found out a quality standard with a set of quality factors (completeness, flexibility, understandability, integration, correctness and implement ability) in order to evaluate the quality of data models (Arsovski *et al.*,2012 and Moody, 2005). Flexibility, understandability, integration, correctness and implementability were ignored in this analysis since they cannot be easily quantified (Moody,2003).

The response rate of authors for the evaluation of the existing tools/systems and approaches was low. Thus, completeness, which is the user requirement embedded into the data model as a set of attributes was selected as the quality factor for evaluation as there were many published research articles available to obtain an idea on completeness.

RESULT AND DISCUSSION

The outcome of the analysis of tools/systems and approaches is summarized in Table 1.

Table 1: Summary of the tools/systems and approaches

Tools and Target User	Approach Used	User Intervention	Completeness of the Tool
(Choobineh, <i>et al.</i> ,1992), (Choobineh, <i>et al.</i> ,1988) DB Designers and end users	Consist of two systems <ul style="list-style-type: none"> • Form Definition System: to create forms to collect end users requirements. • Expert DB Design System: to produce ERD based on form analysis. Rules are divided in to six phases (form selection, entity identification, attribute attachment, relationships identification, cardinality identification and consistency checking. 	Yes. Except the rules in first phase of the Expert DB Design System, rules in other phases used in conjunction with a designer dialog. (Assume users are experienced DB designers).	For completeness, the approach should be combined into other sources in addition to forms such as natural language description.
(Lukovi, <i>et al.</i> ,2007), (Pavicevic, <i>et al.</i> ,2006), (Mogin, and Luković), (Pavicevic, <i>et al.</i> ,2005), (Mogin, <i>et al.</i> ,1994). DB Designer and end users	<ul style="list-style-type: none"> • conceptual modeling of a DB schema; Form type concept was used (tree structure over the instances of component types). Derived by generalization and introducing certain structuring rules into screen forms. Designer creates initial set of attributes and constraints of the form type. • automated design of relational DB sub schemas in the 3rd normal form • checking the consistency of constraints embedded into a DB schema and a set of sub schemas • automated integration of sub schemas into a relational DB schema 	Yes. Using the screen form designers need to specify form types of various structures. Then the modeling process is raised to the level, which is closer to the users without an advanced knowledge of the DB design.	This tool can be even used for complex systems and it is capable of producing an integrated DB schema of a high quality in a reasonably short time. The tool is practically used to generate DB schemas.

(Veronica. <i>et al</i> ,1989) DB designer	Two modes exist: <ul style="list-style-type: none"> • Expert mode: requirements are state directly • Novice mode: requirements are inferred from examples and purposeful dialogue. Rules and heuristics are used to make inferences from examples. 	Yes. Need DB designer to review the requirements collected.	Results are in the expected way.
(Mfourga, 1997) DB Designer	From form-based interfaces of legacy systems. <ul style="list-style-type: none"> • Form Analysis. Two types of analysis used; Static Analysis; Identifies structural components and their relationships based on logical and physical aspects of form & Dynamic Analysis; Discovers constraints among components: cardinality constraints, functional dependencies, and existence dependencies. • Extracting ERD. entity derivation, relationship derivation, attribute attachment, cardinality determination, conceptual normalization, and schema integration 	This approach has not been yet automated. The overall process needs user interaction, especially for form analysis.	They recommend that this approach to automate and can supplement existing DB reverse engineering techniques where forms constitute important uses of the DB
(Shu, <i>et al</i> ,1983) DB Designers	To collect relevant information needed for DB design. Two groups of data identify based on forms, such as data and integrity constraints data and anticipated process which is use, modify or produce data. Form headings and hierarchical structure of forms used.	It is manual process. It can be understood by both specialist and non-specialist. Outcome (DB design specification) is formal, & machine manipulated.	50 cases were used to applied the theory in manually and the feedback was encouraged them.
(Wu, <i>et al</i> ,2004) Decision Suppoer System developers	<ul style="list-style-type: none"> • Form Analysis: Given a set of business forms, decompose them into structure and joined data. • Heading structure design; to find relationships. • Meta-template design; heading structures serve as basis for designing meta-templates and DBs. 	Not automated the process of DB design though all relevant data is there.	Feedback was encouraged them to recommend he approach to automate with further studies.

Most of the tools/systems and approaches supported DB designers to ease their task (Choobineh *et al.*,1992 and Lukovi *et al.*,2007). Both DB designers and users were assisted to collect correct requirements accurately through form analysis (FA) (Shu *et al.*,1983 and Pavicevic *et al.*,2005). Some tools/systems and approaches among the above aid to generate DB for novice users with minimum DB knowledge (Veronica *et al.*,1989). Completeness of outcomes were in the expected way excluding a tool which was proposed to combine Natural Language with FA to improve its completeness (Choobineh *et al.*,1992).

The majority used form features such as Form Type, Form Instance, Form Schema, Form Template, Form Title, etc. to develop the base of tools/systems and approaches. Form Type is a collection of form field. Form schema is associated constraints. Form Template is medium dependent representation. Form instance is a collection of value for form fields (Choobineh *et al.*,1988 and Choobineh *et al.*,1992). A majority applied rules/heuristics on analyzed form features to identify the components of ERD/DD.

CONCLUSIONS

It has been identified that all existing tools or systems need user intervention to generate ERD. The user must have a technical knowledge to generate ERD/DD and improve accuracy of outcomes. Thus, these tools/systems are not affordable for SMEs, to enhance IT adaption for their business.

According to the analysis based on conclusions given by the relevant authors of the tools/systems and approaches were achieved in the satisfactory level of the completeness of the generated ERD/DD as some of them use their tools for real application too. In addition, most of the tools are working properly by producing the correct ERD/DD, even for the complex DB requirements. Positive feedbacks of the outcomes emphasize that FA is a good approach for the DB design process. Forms use in the business help to gather system requirements easily and it is easy to read and understand by any user since it is a methodological way. Finally, it could be concluded that FA is one of the best approaches to develop a tool that is user friendly (used even by non-technical people) without any cost to generate ERD/DD.

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CHARACTERIZATION OF SILICA EXTRACTED FROM POST HARVEST RESIDUE

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INTRODUCTION

Silicon is one of the most widely used resources in modern technology. Industrially speaking silicon is the basis of semiconductors, glasses, ceramics, insulators, moisture shields, fillers, solar cells, etc. These devices require pure silica, which is currently produced by smelting and high end techniques. Development of a simple low energy and cost effective production of pure silica is desirable and welcome by many industrial application.

In recent years, several researchers (Kalapathy *et al.*, 2000; Nittaya Thuadaj *et al.*, 2008; Dissanayake *et al.*, 2013) have reported that the production of pure nanocrystalline Si and SiO₂ from Rice Husk Ash (RHA) is possible and these RHA constitute 80 - 90 % of silica. This has led us to believe that a similar standard of silica may also be existing in other post-harvest residues such as coconut husk and rice straw. Very few investigations have been done in Sri Lanka to extract silica from post-harvest residues (Ismail and Lokuliyana, 1983; Lianage *et al.*, 1991 - 1993).

The objective of this study is to conduct a preliminarily investigation of the physical properties of Sri Lankan based post-harvest residues such as Rice husk, Coconut husk and Rice straw, and to extract silica from them to compare and see whether these could be further synthesized for possible usage in industry.

METHODOLOGY

Moisture content

Standard oven dried method was used to determine the moisture content of each post-harvest residues used in this study. An empty aluminum pan was weighed using an electronic balance to the nearest 0.1 mg. The grounded residue was then placed on the pan and its wet weight was measured. The pan containing residue was heated in an aluminum pan at 125 °C until a constant weight was achieved. The pan containing the dried material was cooled to room temperature in a desiccator and then its dry weight was measured. The moisture content of the residue was

determined using the equation, $MC = \left(\frac{W_{wet} - W_{dry}}{W_{wet}} \right) \times 100$, where, MC is the moisture content (%),

W_{wet} is the wet weight of the residue and pan, and W_{dry} is the dry weight of the residue and pan.

Bulk density

An empty container (7 ml) was weighed using an electronic balance to the nearest 0.1 mg. The container was filled with the post-harvest residue used in this study and was slightly compressed to ensure absence of large void spaces. The container and the residue were then weighed. The wet

bulk density was determined using the equation, $\rho_{bulk} = \frac{W_2 - W_1}{V}$, where, ρ_{bulk} is the bulk density,

W_2 is the weight of the container and residue, W_1 is the weight of the container and V is the volume of the container

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Porosity

Standard water pycnometer method was used to determine the porosity of each post-harvest residue used in this study. A sample residue of approximately 5 ml was taken in a 10 ml graduated cylinder. To avoid floating of residue, a wire mesh was used to cover the top. Distilled water (5 ml) was then poured gradually until the water level was above the residue. Cylinder was gently rocked several times to remove air bubbles trapped inside. The amount of added distilled water and the settled water level in the cylinder containing residue were recorded. The percentage of porosity of the residue was determined using the equation, $P(\%) = \left(\frac{V_i - V_f}{V_s} \right) \times 100$, where, P is the porosity of the residue (%), V_i is the initial total volume of the residue and the added water, V_f is the final total volume of the residue and the added water, V_s is the volume of the residue.

Sample preparation to extract silica

The raw post-harvest residue was washed and burnt in air until it became black ash. This black ash residue was further put into a muffle furnace at 700 °C for 2 hours until it became white ash. This white ash sample was used to extract silica. This process was done separately for each raw post-harvest residue and the samples (Rice Husk Ash (RHA), Coconut Husk Ash (CHA) and Rice Straw Ash (RSA)) were obtained.

Thermogravimetric analysis (TGA)

Thermogravimetric analysis was done for each post-harvest residue to observe their mass reduction in different stages of combustion. All the measurements were taken in the temperature range of 25°C to 700°C at a heating rate of 10 °C/min.

Extraction of silica

Extraction of silica was done for RHA, CHA and RSA samples separately in the following method. Ten grams of each sample was stirred in 80 ml distilled 2.5 M sodium hydroxide solutions. These were then boiled in a covered 250 ml Erlenmeyer flask separately for 3 hours. The solutions were filtered using the Whatman No. 41 ashless filter paper and the respective residues were washed with 20 ml boiling water separately. Each filtrate was allowed to cool down to room temperature and added 5 M H₂SO₄ until they reach pH 2. Then NH₄OH was added to each filtrate until they reach pH 8.5 and allowed to be at room temperature for 3.5 hours. The silica as residue was separated from each suspension by suction filtration using a Buchner funnel and thoroughly washed. Each residue was then oven dried at 120 °C for 12 hours and cooled down to room temperature.

XRD analysis

X-ray diffraction (XRD) patterns of extracted silica samples from RHA, CHA and RSA were obtained by a XRD system using an acceleration voltage of 40 kV and current 30 mA. The diffraction angle 2θ was scanned 10° to 80° at a rate of 4°/min.

RESULTS AND DISCUSSION

The results of moisture content, bulk density and porosity of the raw post-harvest residues are presented in Table. 1. The moisture content of the rice husk obtained in this study is 10.4 % and this value is comparable to the value of 10.7% reported by Zhou *et al* (2009) for the rice husk from China, the value of 8.7 – 10.5 % reported by Ismail *et al* (1983) for various rice husk from Sri Lanka and the value of 9.38% reported by Olawale *et al* (2012) for the rice husk from Nigeria. However, it is lower than the values reported by Yaning Zhang *et al* (2012) for short grain 5.63% and long grain 4.72% rice husk. This lower value of moisture content may be mainly due to

drying procedure. The sample used in this study was oven dried at 125⁰C whereas the samples reported by Yaning Zhang *et al* (2012) were dried at 105⁰C until a constant weight is achieved. The moisture content of the rice straw is 14.8% and the coconut husk is 12.7%. These values are higher than the value obtained for the rice husk under the same condition and processing method.

Table 1: Moisture content, the bulk density and porosity of the post-harvest residues

Post-harvest residues	Moisture content (%)	Bulk density (kg/m ³)	Porosity (%)
Rice husk	10.4	351.4	54
Coconut husk	12.7	198.4	60
Rice straw	14.8	220.8	56

The moisture content of 14.8 % estimated for the rice straw in this study is much higher than the values reported by Yaning Zhang *et al.*, (2012) for short grain 6.92% and long grain 6.58%. These high moisture content variations may be due to drying procedure, geographical condition of the rice production and the variety. The bulk density obtained in this study for rice husk and rice straw are 351.4 kg/m³ and 220.8 kg/m³ respectively. These values are comparable to the values of 377.24 kg/m³ and 166.29 kg/m³ for long grain rice husk and rice straw respectively obtained by Yaning Zhang *et al.*, (2012). Slight variation of these values may be due to different varieties of rice straw used in these studies and their different geographical location in the production of paddy. Figure 1 shows the Thermal Gravimetry Analysis (TGA) of rice husk, coconut husk and rice straw. In all three samples, two or more stages of decomposition regions were observed. First region may be due to the removal of water and the last region represents the burning of fixed carbon in the samples. Except rice husk other two samples (coconut husk and the straw) seems to have undergone multiple stage decomposition indicating the removal of other kinds of volatile components.

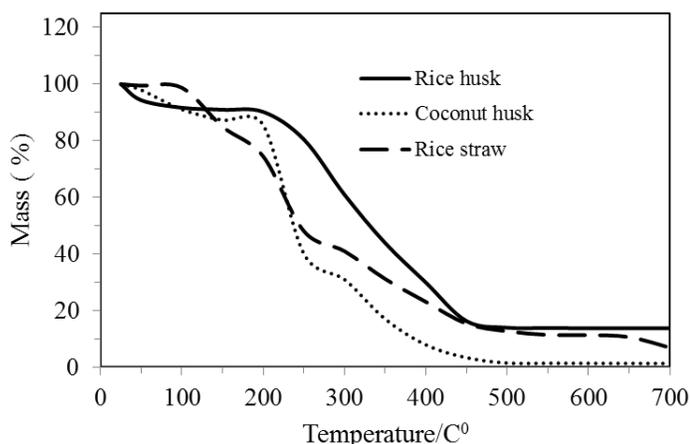


Figure 1: TG curves for Rice husk, Coconut husk and

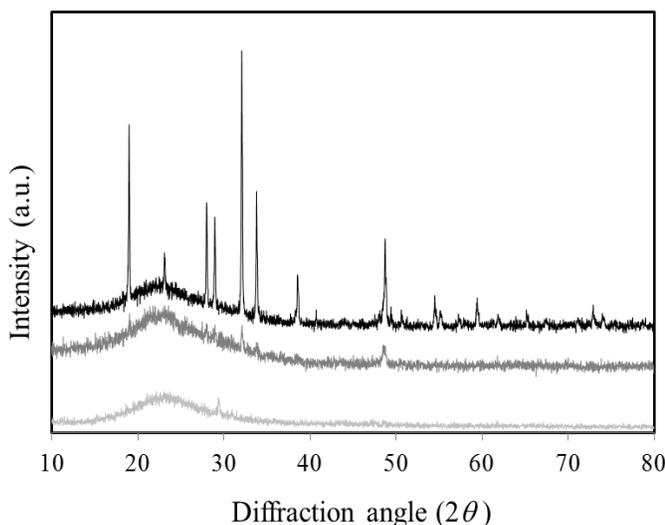


Figure 2: XRD spectra of silica from RHA, CHA and

Table 2 shows the onset and offset temperatures associated with the combustions and the mass loss.

Table 2: Onset and offset temperature associated with the combustion and the mass loss

TG	Post-harvest residues	Onset combustion Temperature	Off set combustion Temperature	Mass loss (%)
	Rice husk	200 ⁰ C	450 ⁰ C	85.0
	Coconut husk	75 ⁰ C	425 ⁰ C	98.5
	Rice straw	100 ⁰ C	450 ⁰ C	90.0

graph reveals (Figure1) that the water content in the rice husk released in the temperature interval 25⁰C - 120⁰C is around 10%. It also shows clearly that the final residues obtained in the form of ash from rice husk, coconut husk and rice straw are 15%, 1.5% and 10% respectively. XRD spectra of silica obtained from these ashes (Figure2) shows broader peaks centred at 2 θ angle of 22⁰ confirmed the amorphous nature of the silica (Kalapathy *et al.*, 2000 and Dissanayake *et al.*, 2013). The peak associated with rice husk is much broader than the other two. The initial analysis of XRD spectra using the Scherrer's formula reveals that the rice husk has particles in the range of nano scale, however further investigation is needed for conformation. Further the XRD spectra indicates that the quantity of silica in percentage obtained in rice straw and coconut husk are much lower than obtained in rice husk.

CONCLUSIONS/RECOMMENDATIONS

The data obtained in this study shows that rice husk is a more suitable post-harvest waste material than coconut husk and rice straw for further investigation to obtain industrial standard silica having particle size possibly in the range of nano scale.

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REDUCTION OF WATER HARDNESS USING PLANT PARTS

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INTRODUCTION

In Sri Lanka, the quality of potable water is governed by Sri Lanka Standards Institute standard SLS 614: 1983, which describes the physical, chemical and biological qualities of potable water safe for human consumption. Water hardness can be defined as the sum of polyvalent cations present in water (Benefield and Morgan, 1990) and also defined as the total concentration of alkaline earth (Group 2) ions, which are mainly Ca^{2+} and Mg^{2+} . Hardness is usually expressed as the equivalent amount of CaCO_3 in mg *per* litre. Assuming that concentrations of other polyvalent cations are negligible, hardness can be classified as magnesium hardness or calcium hardness; total hardness being the sum of the two. Based on the associated anions, hardness can be classified as temporary (caused by HCO_3^-) or permanent (caused by Cl^- and SO_4^{2-}). Effects of hardness can be mostly on industries and health. Effects on industries are mainly due to formation of scale inside water pipes. Health effects of hardness are disputed. The World Health Organization (2011) states that hardness levels found in drinking water are not of any health concern. An important issue in hard water is the objectionable taste introduced by ions present. There are many methods to reduce hardness. Chemical methods involve lime softening, ion-exchange softening and chelation. Electrocoagulation (Malakootian and Yousefi, 2009) is an example of a physical hardness removal method. All these methods are either expensive or difficult to implement because of the technical knowledge and skills required. If plant parts can remove or reduce water hardness, it would be an economical, environmentally sustainable and user-friendly alternative method compared to other methods of hardness removal. It would be useful to compare this method with boiling and analyze the combined effect of boiling and plant adsorption on water hardness.

The objectives of this research were to determine the levels of water hardness in some selected areas in Sri Lanka before and after boiling, to determine suitable plant parts to reduce hardness and to optimize reduction of hardness by the selected plant parts with respect to weight and time of equilibration on un-boiled hard water.

METHODOLOGY

In order to determine the hardness levels in Sri Lanka, nine locations (wells (W) and tube wells (T)) in North and North-Central provinces were selected (Anuradhapura (A)-3, Jaffna (J)-4, Madawachchiya (M)-1 and Vavuniya (V)-1). Three samples of surface water were taken from each location and were analyzed before and after boiling using the following methods; calcium hardness: filtered samples were analyzed using flame photometry, total hardness: added 2.0 ml of pH 10 buffer to 25.0 ml of filtered samples and titrated against 0.01 M EDTA with EBT indicator, magnesium hardness: the difference between total and calcium hardness. pH of each sample was also recorded. Based on the results, 2 levels of hardness were decided (L1: average hardness before boiling, L2 : average hardness after boiling). Synthetic hard water was prepared using CaCO_3 and MgCO_3 while maintaining similar pH levels (with the use of dilute HCl and NH_4OH).

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The following plant parts were chosen for this study: Moringa (*Moringa oleifera Lam.*) bark – air dried (3 cm x 1.5 cm), rice hull – air dried - uncrushed and crushed (600 µm < size < 1.18 mm), Nelli (*Phyllanthus emblica*) flesh - raw and water melon (*Citrullus lanatus*) seeds – air dried. Known weight of each plant part was equilibrated with 100 ml of hard water in a mechanical shaker for 1 hour. Three replicates were analyzed for each level of hardness for each plant part. After equilibration, the samples were filtered and analysed for total and calcium hardness. Based on the results, Moringa bark and crushed rice hull were chosen for optimization. Optimization with respect to weight was done by equilibrating different weights of plant parts (1 – 10 g) with 100 ml of hard water (L1) for 3 hours. Then the samples were filtered and analyzed. Based on the results, best weights were chosen from the selected plant parts and optimization was carried out with respect to time by equilibrating known weights of plant materials with 100 ml of hard water (L1) for different time periods (3 – 24 hours).

RESULTS AND DISCUSSION

A large variation of hardness was detected among the tested water samples from North and North-Central provinces (AW1 = 757 ppm, AW2 = 330 ppm, AW3 = 360 ppm, JT1 = 760 ppm, JT2 = 760 ppm, JW1 = 881 ppm, JW2 = 490 ppm, MW = 770 ppm, VW = 820 ppm).

Table 1 - Levels of hardness and composition of synthetic hard water (Hardness in ppm)

Level	Description	Total hardness	Calcium hardness	Magnesium hardness
L1	Un-boiled	850	475	375
L2	Boiled	600	240	360

In order to represent the total range of hardness, AW1, JW1 and VW samples were chosen for this study. According to the results, total hardness can be reduced by 29 % and calcium hardness by 49 % by boiling. Magnesium hardness is not considerably affected by boiling. This shows that in Sri Lanka, it is calcium hardness that contributes more to total hardness. It might be possible that the major amount of magnesium hardness is present in the form of sulphates and chlorides causing permanent hardness. Based on these results, two levels of total hardness were decided upon; L1: before boiling, L2: after boiling.

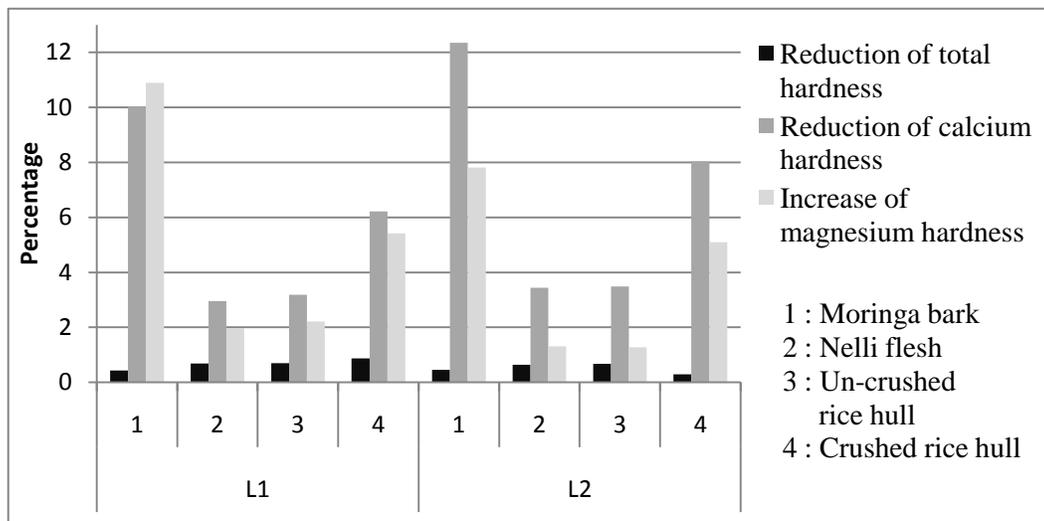


Figure 1 - Efficacy of plant parts in removing hardness at levels L1 and L2.

Figure 1 depicts the results for efficacy of plant parts in reducing hardness at L1 and L2. Plant parts for this study were selected depending on their availability in areas where there are higher levels of hardness and cost. The ability of reducing calcium hardness was in the following order; Moringa bark (10 – 12 %), crushed rice hull (6 – 8 %), Un-crushed rice hull ≈ Nelli flesh (3 %).

An interesting observation is that, while calcium hardness is reduced, magnesium hardness is increased, thus resulting in no effect on total hardness. This might be due to leaching of magnesium from the plant material. Crushed rice hull showed a higher ability to reduce calcium hardness at both levels than un-crushed rice hull. Water melon seeds were not taken for the study because of excessive leaching of organic substances under equilibration which gave an extensive coloration to the solution, interfering in the analysis. Based on the results Moringa bark and crushed rice hull were selected as suitable plant parts for optimization.

The results show that both Moringa bark and crushed rice hull show a higher ability (about 2 % more) in reducing calcium hardness in boiled water compared to un-boiled water thus showing a higher efficacy when applied to boiled water. It can be concluded that when boiling is combined with application of these plant parts, the calcium hardness can be reduced by about 58 – 62 % (49 % by boiling, 6-8 % by plant parts).

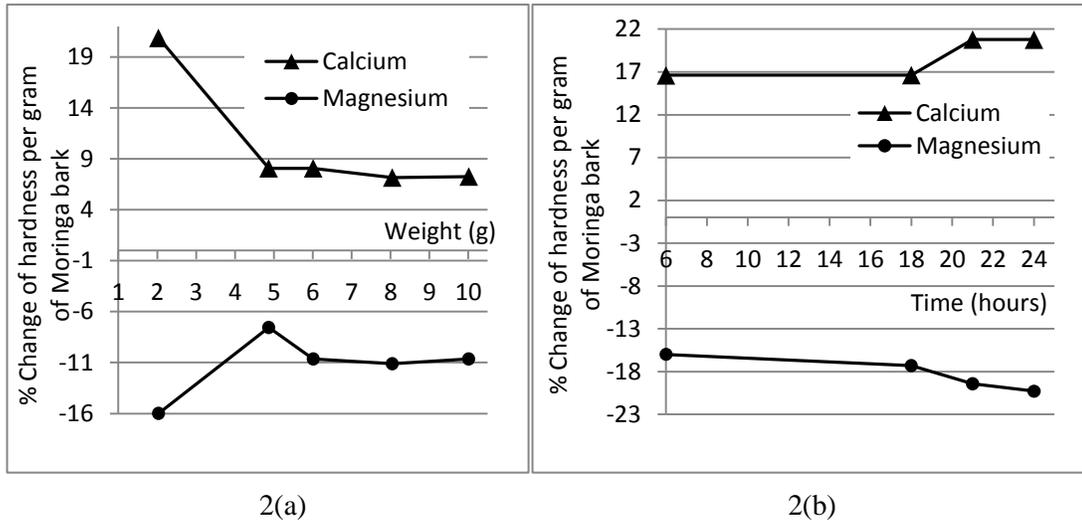


Figure 2(a) - Results for weight optimization with Moringa bark.
 2(b) - Results for time optimization with Moringa bark.

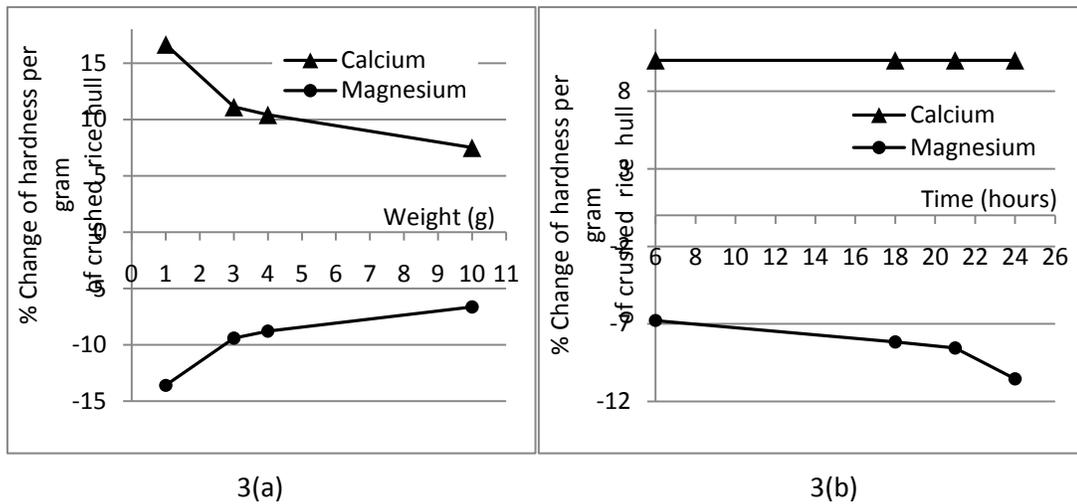


Figure 3(a) - Results for weight optimization with crushed rice hull.

Figure 2(a) depicts the result for weight optimization for Moringa bark (negative values of magnesium hardness denote increase of magnesium hardness by leaching). According to the results in Figure 2(a), the best weight of Moringa bark in reducing calcium hardness is 2 g. It is also noticeable that, as the weight increases, the efficacy of removing calcium hardness initially decreases and remains constant for more than 5 g. At any given weight, removal of calcium hardness is approximately similar to increase of magnesium hardness. According to Figure 2(b), best time period for reducing calcium hardness by Moringa bark is 6 - 16 hours. A similar pattern can be observed for crushed rice hull as well (Figure 3(a) and 3(b)). The best weight for reducing calcium hardness using crushed rice hull is 2g. According to figure 3(b), time of equilibration does not have an effect on removing calcium hardness with crushed rice hull.

CONCLUSIONS / RECOMMENDATIONS

Boiling of the hard water reduces the total hardness by 29 % and calcium hardness by 49 %. Magnesium hardness is not considerably affected by boiling. Although Moringa bark and crushed rice hull cannot be applied for removal of total hardness, it can be used to reduce calcium hardness. Moringa bark has the highest ability to reduce hardness in both boiled and un-boiled water. (Calcium hardness in un-boiled water by 10 % and in boiled water by 12 %) Crushed rice hull has the ability to reduce calcium hardness by 6 % in un-boiled water and in boiled water the efficiency is 8 %. According to the results of optimization, best weight of Moringa bark is 2 g with time period of 6 – 16 hours. For crushed rice hull, best weight is 1g with time period of 6 hours.

It is recommended that this study be carried out using lower weights of plant parts in order to explore the possibility of obtaining a greater hardness reducing efficiency. It is also possible to determine hardness reducing efficacies of different plant parts using the above procedure. Since synthetic hard water used in this study consists of mostly permanent hardness, it can be recommended that the same plant parts be used against naturally occurring hard water to determine whether there is a difference in effectiveness.

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CYTOTOXIC CONSTITUENTS FROM THE ENDOLICHENIC FUNGUS *Hypoxylon polyporus*

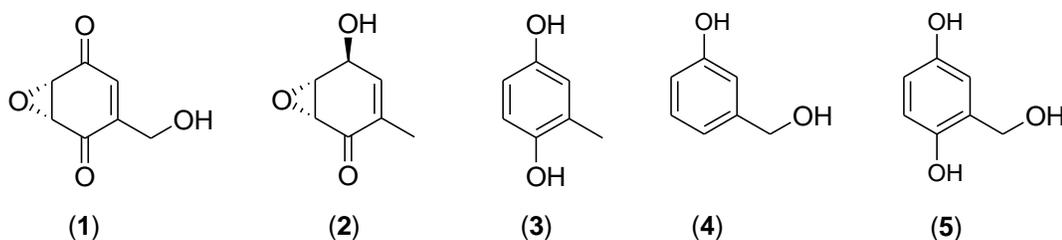
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INTRODUCTION

Recent studies have demonstrated that endolichenic fungi are rich sources of structurally diverse small-molecule natural products, some with interesting biological activities (Wijeratne *et al.*, 2012). In our continuing search for bioactive and/or novel metabolites of plant- and lichen-associated fungi we investigated the endolichenic fungi, *Hypoxylon polyporus* inhabiting in the thallus of the lichen *Cladonia leporina* (Lecanorales) collected at the Archbold research Station Florida, USA. Although few chemotaxonomic evaluations have been carried out (Bitzer *et al.*, 2008; Hsieh *et al.*, 2005) this constitutes the first report of bioactivity directed chemical investigation of *H. polyporus*. Herein we report the bioactivity directed fractionation, isolation of cytotoxic (-)-phyllostine (1) and toluhydroquinone (3) and other constituents 2, 4, and 5 from ethyl acetate (EtOAc) extract of a culture broth of *H. polyporus*.



METHODOLOGY

General Experimental Procedures. 1D and 2D NMR spectra were recorded with a Bruker Avance III 400 spectrometer at 400 MHz for ¹H NMR and 100 MHz for ¹³C NMR using residual solvent as an internal reference. Low-resolution MS were recorded on Shimadzu LCMS-QP8000a. Analytical and preparative thin layer chromatography (TLC) were performed on pre-coated 0.25 mm thick plates of silica gel 60 F₂₅₄.

Cultivation and Isolation of Metabolites of *Hypoxylon polyporus*. A seed culture of the fungus *H. polyporus* (FL1289) grown on PDA for two weeks was used for inoculation. Mycelia were scraped out, mixed with sterile water, and filtered through a 100 μm filter to separate spores from the mycelia. Absorbance of the spore solution was measured (at 600 nm) and adjusted to between 0.3 and 0.5. This spore solution was used to inoculate 2.0 L Erlenmeyer flask holding 1.0 L of the potato dextrose broth (PDB) medium containing 0.25 mM CuSO₄ and incubated at 160 rpm and 28 °C until the glucose in the medium was completely consumed (glucose level was monitored using URISCAN glucose strips). Mycelia were then separated by filtration, and the filtrate was neutralized (pH 7.0) and extracted with EtOAc (3 × 0.5 L). The combined EtOAc layer was washed with water, dried over anhydrous Na₂SO₄, and evaporated under reduced pressure to give the crude EtOAc extract (521.0 mg), which showed cytotoxic activity. A portion of this extract (455.0 mg) was dissolved in 80% aq. MeOH and partitioned with hexanes to give hexanes fraction (1.7 mg). The 80% aq. MeOH fraction was diluted with water to make it to 50% aq. MeOH and partitioned with CHCl₃ to yield the CHCl₃ fraction (90.4 mg) and 50% aq. MeOH

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fraction (326.0 mg). A portion of the cytotoxic 50% aq. MeOH fraction (292.0 mg) was subjected to chromatography over a column of SiO₂ made up in CH₂Cl₂ and eluted with CH₂Cl₂ and CH₂Cl₂ containing increasing amounts of MeOH and the resulted column fractions were pooled according to their TLC patterns to yield five major fractions, F₁ – F₅. The fraction F₂ which showed strong cytotoxicity against all five cancer cell lines used at 5 μg/mL was subjected to prep TLC (eluent; 6% MeOH in CH₂Cl₂) to isolate (-)-phyllostine (1), (+)-epiepoformin (2) and 2-methylbenzene-1,4-diol (toluhydroquinone) (3). Fraction F₄ was found to be a single compound by TLC and the analysis of spectroscopic data revealed that it is 3-hydroxymethylphenol (4). Fraction F₅ yielded 2-hydroxymethylbenzene-1,4-diol (gentisyl alcohol) (5) on crystallization with MeOH/CH₂Cl₂.

Cytotoxicity Assay. Relative cell growth and survival were measured in 96-well microplate format using the fluorescent detection of resazurin (AlamarBlue) dye reduction as an end point. Extracts, fractions and compounds were tested against human non-small-cell lung cancer (NCI-H460), metastatic prostate adenocarcinoma (PC-3M), CNS glioma (SF-268), breast cancer (MCF-7), and human metastatic breast adenocarcinoma (MDA-MB-231). Serial dilutions of test compounds or vehicle control (DMSO) were added to triplicate wells. After 72 h incubation, dye solution was added to each well (1:10 dilution). After brief agitation, incubation was continued for 4 h at 37 °C before data acquisition using a microplate fluorometer (Ex/Em: 560/590). Mean fluorescence intensity per well as a measure of relative viable cell number in compound-treated wells was compared to that of DMSO treated wells. The conventional chemotherapeutic drug doxorubicin served as a positive control.

RESULTS AND DISCUSSION

Compound 1 was obtained as a colorless oil. ¹H and ¹³C NMR (DMSO-*d*₆) together with HSQC data of 1 revealed that it contained a hydroxymethylene group [δ_{H} 4.17 (1H, ddd, $J = 18.6, 5.5, 2.1$ Hz), 4.29 (1H, ddd, $J = 18.6, 5.5, 2.3$ Hz); δ_{C} 57.2], three methines of which one was vinylic, [δ_{H} 6.95 (m); δ_{C} 129.6] and other two were oxygenated, [δ_{H} 3.94 (dd, $J = 4.0, 2.5$); δ_{C} 53.9 and δ_{H} 3.97 (d, $J = 4.0$); δ_{C} 54.0] and three quaternary carbons of which one was vinylic, (δ_{C} 149.7) and other two were carbonyls (δ_{C} 191.9 and 192.1). The OH protons of hydroxymethylene appeared at δ 5.41 (t, $J = 5.5$ Hz). These data accounted for C₇H₆O₃. The low resolution APCI-MS, m/z 155 [M+H]⁺ indicated the presence of an additional oxygen atom in the molecule suggesting an epoxide ring incorporating the two oxygenated methines at δ_{H} 3.94 and 3.97. The hydroxymethylene protons at δ 4.17 and 4.29 showed HMBC correlations to both vinylic carbons at δ 129.6 and 149.7 and to carbonyl carbon at δ 191.7 placing the CH₂OH group on the quaternary vinylic carbon. Thus the planar structure of 1 was determined as 3-(hydroxymethyl)-7-oxa-bicyclo[4.1.0]hept-3-ene-2,5-dione. Comparison of spectral data with those of reported (Okamura *et al.*, 2003) confirmed its identity as (-)-phyllostine (1).

Compound 2 was obtained as a colorless film. Its ¹H NMR data (CDCl₃) showed a close resemblance to 1. The major difference was found to be the absence of a CH₂OH group in 2; instead it showed the presence of a CH₃ group at δ 1.83 (t, $J = 1.2$ Hz) and an additional hydroxymethine group [δ 4.66 (brs)]. Thus the planar structure of compound 2 was determined as 5-hydroxy-3-methyl-7-oxa-bicyclo[4.1.0]hept-3-en-2-one. Comparison of spectral data of 2 with those reported (Okamura *et al.*, 2003) confirmed its identity as (+)-epiepoformin (2).

Compound 3 was obtained as a colorless oil. ¹H NMR spectrum of 3 showed the presence of a 1,2,4-trisubstituted benzene ring [δ 6.55 (1H, d, $J = 8.6$ Hz), 6.53 (1H, d, $J = 3.0$ Hz), 6.44 (1H, dd, $J = 8.6, 3.0$ Hz)] and a methyl group attached to a benzene ring (δ 2.11, s). ¹³C NMR spectrum showed three aromatic quaternary carbons of which two are oxygenated (δ 149.6 and 147.9) indicating the presence of two OH groups while the signal at δ 125.5 accounted for the quaternary C bearing the CH₃. The remaining aromatic methines appeared at δ 117.6, 115.5 and

113.0. The signal at δ 16.2 indicated the presence of aromatic CH_3 group. Comparison of the NMR data of this compound with those of reported (Biorad NMR database) led to the identification of 3 as 2-methylbenzene-1,4-diol (toluhydroquinone).

Compound 4 was obtained as off white oil. ^1H and ^{13}C NMR spectra (DMSO- d_6) together with HSQC data indicated the presence of a phenolic OH [δ_{H} 9.31 (1H, s); δ_{C} 157.3], 1,3-disubstituted benzene ring {[δ_{H} 7.08 (1H, t, $J = 7.8$ Hz); δ_{C} 129.0], [δ_{H} 6.74 (1H, m); δ_{C} 113.2], [δ_{H} 6.70 (1H, br d, $J = 7.5$ Hz); δ_{C} 116.9], [δ_{H} 6.60 (1H, br dd, $J = 8.0, 2.5$ Hz); δ_{C} 113.5]} and a hydroxymethyl group [δ 4.40 (2H, d, $J = 5.8$ Hz, CH_2), 5.10 (1H, t, $J = 5.8$ Hz, OH); δ_{C} 62.9]. The aromatic quaternary carbon bearing hydroxymethyl group appeared at δ_{C} 144.3. Thus compound 4 was identified as 3-hydroxymethyl phenol. Comparison of ^{13}C NMR data of 4 with those of reported (Mikami *et al.*, 1996) confirmed its identity.

Compound 5 was obtained as white crystalline solid. ^1H NMR spectrum (DMSO- d_6) of 5 indicated that it consisted of two phenolic OH groups [δ 8.55 and 8.54 (1H each, s)] 1,2,4-trisubstituted benzene ring [δ 6.73 (1H, d, $J = 3.0$ Hz), 6.53 (1H, d, $J = 8.5$ Hz), 6.40 (1H, dd, $J = 8.5, 3.0$ Hz)], OH group [δ 4.89 (1H, br)] and hydroxymethylene group [δ 4.39 (2H, d, $J = 4.2$ Hz)]. Thus the structure of 5 was elucidated as 2-hydroxymethylbenzene-1,4-diol (gentisyl alcohol). Comparison of ^1H NMR data with those reported (Sakamura *et al.*, 1971) confirmed its identity.

Compounds 1, 2, and 3 were evaluated for cytotoxicity against five cancer cell lines and the results are summarized in Table 1. Doxorubicin served as the positive control.

Table 1. Cytotoxicity (AlamarBlue[®]) assay data of compounds 1–3.

Compound	Concentration		% Inhibition				
	($\mu\text{g/mL}$)	(μM)	PC-3M	NCI-H460	SF-268	MCF-7	MDA-MB-231
1	1.25	0.008	90.4	99.9	94.8	99.3	79.4
2	1.25	0.009	3.6	-4.2	-5.8	-1.6	-14.3
3	1.25	0.010	-14.2	-10.6	78.2	20.4	25.0
Doxorubicin		1.000	77.4	96.7	78.8	84.9	63.6

It was found that (-)-phyllostine (1) showed strong cytotoxic activity against all five cell lines while toluhydroquinone (3) showed selective cytotoxicity against SF-268.

CONCLUSIONS

Bioactivity-guided fractionation of *H. polyporus* resulted in the isolation of two cytotoxic constituents, (-)-phyllostine (1) and toluhydroquinone (3). (-)-Phyllostine (1) showed strong cytotoxic activity against all five cancer cell lines while toluhydroquinone (3) exhibited moderately weak but selective activity against CNS glioma (SF-268).

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A PRELIMINARY STUDY OF REMEDIATION OF CHROMIUM FROM TANNERY EFFLUENT

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INTRODUCTION

The environment is contaminated by a variety of heavy metals which commonly results from human activities. The effluent and sludge disposed from the leather industries into the rivers are the sources of Cr in the environment. Cr(III) and Cr(VI) are two stable oxidation states that are present in the environment. They show different chemical and biochemical reactivity. Cr(VI) compounds are more soluble, mobile and bioavailable than Cr(III) [1]. Cr(VI) is acutely toxic, mutagenic and carcinogenic in contrast to Cr(III), which has low toxicity and is immobile under moderately alkaline to slightly acidic conditions [2]. Remediation of contaminants by chemical methods has some disadvantages. They are; high cost, need expensive equipment, incomplete removal of contaminants, inability to recycle the products and possible environmental effects posed by the products.

Phytoremediation involves the use of plants to remove toxic substances from the environment. It is a green technology and is more favoured than the conventional methods because it costs less and is environmental friendly and the pollutants absorbed by plants can be extracted for commercial purposes (phytomining).

Plant species are selected for phytoremediation based on their potential to accumulate metals, growth rates and yields and depth of their root zone. This ability of plant species can be used to remediate heavy metals from the contaminated sites [3].

In the leather industry, Cr(III) salts and chromic acid are widely used as chrome tanning agents. During the process, polynuclear Cr(III) complexes bridge the neighboring proteins by coordinating with carboxyl groups. This toughness prevents putrefaction of leather. Effluents discharged into water streams, on standing generate Cr(VI) through oxidation by dissolved oxygen. Conversion of Cr(III) to Cr(VI) is thermodynamically feasible and poses an environmental hazard [4].

The objectives of the study were: to determine the characteristics of tannery waste, to optimize the conditions to sustain growth of *Lemna minor*, and to determine the efficiency of *Lemna minor* to remove chromium from tannery waste.

METHODOLOGY

The aquatic plant *Lemna minor* was collected from a canal in the Rajagiriya area and acclimatized in a fresh water tank in a mesh house.

The industrial effluent was collected from a leather tanning factory in Colombo. The physical parameters of the effluent were measured using calibrated instruments (Hanna pH 211), and

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conductivity (Hanna EC 215); total Cr concentration of the effluent was determined using Atomic Absorption Spectrophotometry (AAS – Varian AA280 FS).

In experiment 1, a litre of each of the diluted raw effluent samples was placed in black plastic basins. *Lemna minor* (6-8 g) was added to each basin which were kept in the mesh house for four days. The initial fresh weight of *Lemna minor* and the pH of the mixture were recorded. This experiment was carried out with 2- fold, 5- fold 10- fold and 20- fold diluted raw effluents. A set of effluent samples were withdrawn at 24 hour intervals for four days. The final fresh weights of the plants were recorded each day. Effluents were analyzed for Cr content by using an Atomic Absorption Spectrophotometer.

In experiment 2, the same procedure was carried out with the effluent of which the pH was adjusted, by adding dilute NH_4OH drop wise, to the optimum pH for growth of *Lemna minor*. In this case both effluent samples and plants were analyzed for chromium content by AAS. Plants in distilled water served as the control.

During the experiment, the sample mixture was replenished by adding distilled water daily to maintain the initial volume of the sample.

All experiments were run in triplicate.

Relative growth of plants in control and experiments were calculated each day during the experimental period as,

$$\text{Relative Growth} = \frac{\text{Final fresh weight (g)}}{\text{Initial fresh weight (g)}}$$

RESULTS AND DISCUSSION

The tannery effluent was greenish blue in colour. The physical and chemical parameters of the effluent are as follows:

Conductivity = $99.4 \pm 0.01 \mu\text{S}$

pH = 3.92 ± 0.01

Total chromium content = $1.52 \times 10^3 \text{ ppm}$

All plants treated in the raw effluent diluted to two-fold and five-fold dilution showed toxic symptoms within a few hours. This is probably due to the high concentration of Cr(VI). Therefore the experiment was carried out in more diluted effluent: ten- and twenty-fold dilutions.

The plants in the control experiment were fresh and normal throughout the experiment.

In experiment 1 with ten fold dilution, plants were fresh and normal on Day one and thereafter, the plants started to show morphological changes. But in experiment 2 with ten fold dilution; most plants were fresh and normal. Compared to experiment 2, significant Cr toxicity was observed from Day two onwards in experiment 1. This may be due to the high concentration of Cr(VI) in the effluent which was toxic to *Lemna minor*. In experiment 2, when the pH was adjusted to the optimum value for plant growth (pH 6.18), most of the Cr(III) precipitated as $\text{Cr}(\text{OH})_3$. This depletes $\text{Cr}(\text{III})_{\text{aq}}$ in the effluent and hence the Cr(VI) bioavailable to plants. As a result, plants did not show growth (nor increase in biomass) and hence, an increase in Relative Growth (Figure 1).

In experiments 1 and 2 of twenty fold dilution, plants were fresh and normal up to Day two, but thereafter started to show morphological changes. Both experiments 1 and 2 showed similar morphology and relative growth, possibly because the pH values are similar in both experiments, and amounts of Cr(III) and Cr(VI) bioavailable were the same (Figure 2).

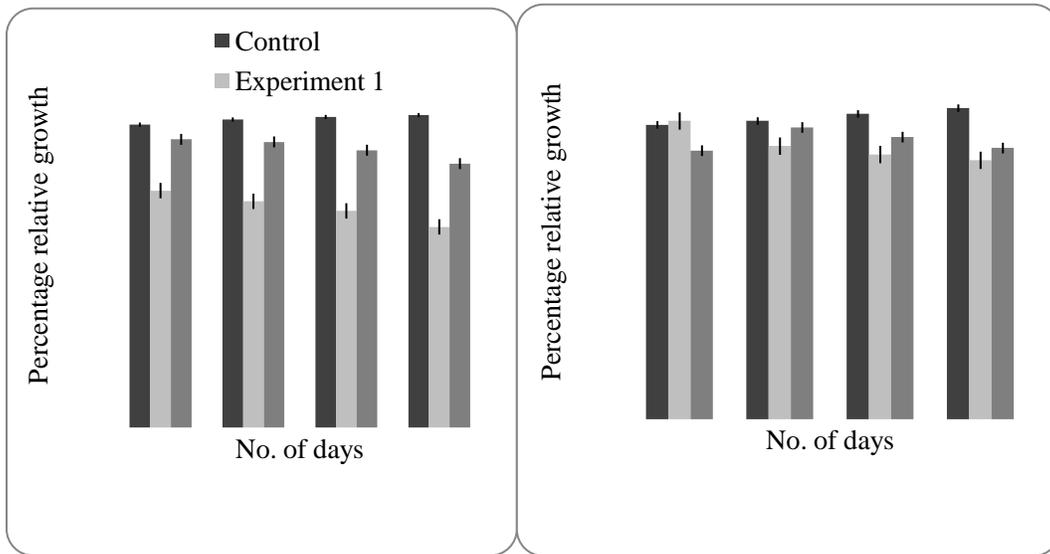


Figure 1 Percentage relative growth of *Lemna minor* in Ten – fold diluted effluent. Figure 2 Percentage relative growth of *Lemna minor* in Twenty – fold diluted effluent.

Control- Plants in distilled water; Experiment 1- Plants in diluted raw effluent; Experiment 2 – Plants in diluted and pH adjusted (pH 6.18) effluent.

Variation of absorption of chromium by *Lemna minor* with time in the ten- and twenty-fold diluted effluents in experiment 2 during the experimental period is shown in Figure 3. In this study, Cr was not detected in the control experiment. According to Figure 3, in experiment 2 of ten fold dilution, the maximum absorption of Cr(VI) was 41.6×10^3 mg/kg DW on Day one. There was no significant difference in Cr(VI) absorption with time. This is because, when the effluent was adjusted for an optimum pH, 6.18, aqueous Cr(III) present in the effluent precipitated as $\text{Cr}(\text{OH})_3$, an insoluble form which will not undergo aerial oxidation to form Cr(VI). Therefore bioavailable Cr(VI) is depleted for *Lemna minor*.

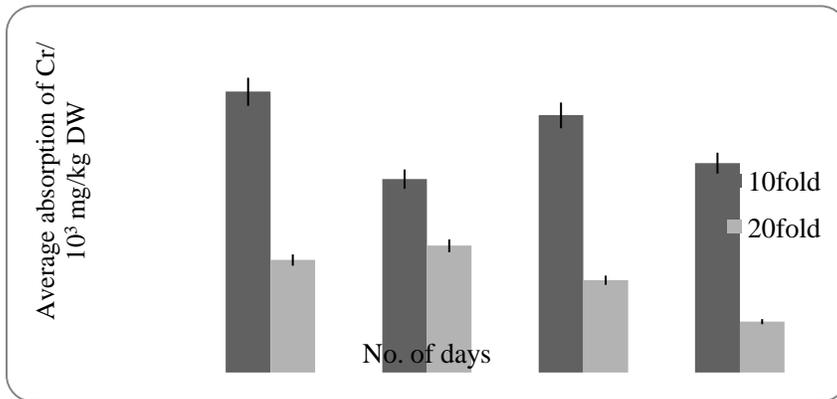


Figure 3 Absorption of chromium by *Lemna minor* from the ten- and twenty fold diluted effluent during the study period.

With twenty – fold dilution, the maximum absorption of Cr in experiment 2 was 18.8×10^3 mg/kg DW in Day two (Figure 3). There was no significant difference in absorption with time as in experiment 2 in ten- fold diluted effluent. Due to the conditions of experiments 1 and 2, Cr

existed mostly as $\text{Cr}(\text{OH})_3$ (pH 6.18) and the soluble form of Cr(III) was less and hence Cr(VI) bioavailable to plants were lower.

Variation of total chromium content of the remaining effluent in experiment 1 with time for both ten- and twenty – fold dilution is given in Figure 4.

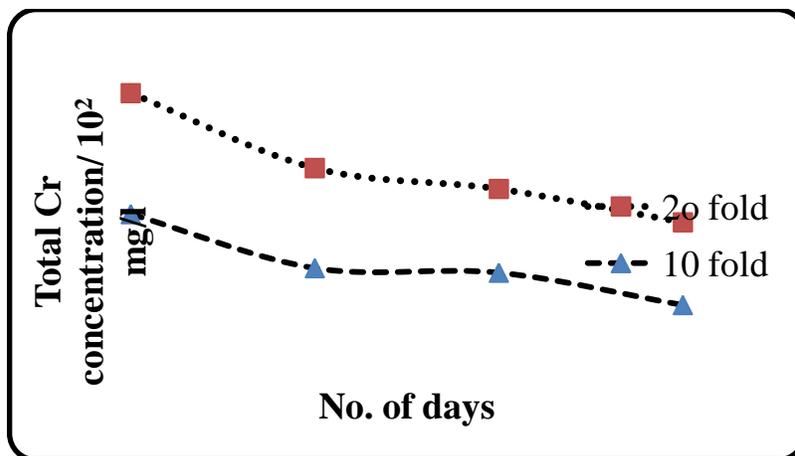


Figure 4 Variation of total chromium content remaining after uptake by *Lemna minor* in ten- and twenty- fold effluent without pH adjustment.

According to Figure 4, during the study period, the total chromium content of both ten- and twenty- fold diluted effluents decreased; plants absorbed Cr(VI) species present in the solution and the Cr(VI) species are formed by oxidation of Cr(III) by air and dissolved oxygen.

CONCLUSION

Tannery effluent was acidic (pH = 3.92) and contained a high chromium content and showed toxicity to *Lemna minor*. The two- and five -fold diluted effluent was toxic to *Lemna minor*, while ten- and twenty- fold diluted effluents showed considerable growth of *Lemna minor* as shown by the Relative Growth. When the pH was adjusted to 6.18, which is optimum for *Lemna minor*, Cr uptake was diminished because at pH 6, the predominant Cr species are $\text{Cr}^{3+}_{\text{aq}}$ and $\text{Cr}(\text{OH})_3$, which are not bioavailable for plants. Low Cr(III) content in effluent means lower bioavailable Cr(VI) and hence lower Cr uptake, less toxicity symptoms and higher Relative Growth.

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PRELIMINARY INVESTIGATION OF CELLULOLYTIC ACTIVITY OF SOME SELECTED FUNGI ON SAW DUST

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INTRODUCTION

Among the widely used sources of non-renewable energy, fossil fuels play a major role. The demand for fossil fuels is ever increasing and is expected to exceed the supply in the near future. Hence, the need for alternate, renewable energy sources is a global requirement.

Lignocelluloses is the most abundant renewable natural resource and substrate available for conversion to fuels. Amongst available cellulosic feed stocks from agriculture and other sources maize is one of the largest crops which is potentially available for fuel production (Somerville *et al.*, 2010). Furthermore, tremendous amounts of cellulose are available as municipal and industrial wastes which contribute to our pollution problems at present. Thus, there is great potential in the use of cellulosic biomass as a renewable source of energy *via* breaking down to sugars that can then be converted to ethanol. Industrially ethanol is produced from corn and sugar which is used as an alternative fuel (Bhat and Bhat, 1997).

The potential quantity of ethanol that could be produced from cellulose is over an order of magnitude larger than that producible from corn. In contrast to the corn-to-ethanol conversion, the cellulose-to-ethanol route involves little or no contribution to the greenhouse effect and has a clearly positive net energy balance (five times better). As a result of such considerations, microorganisms that metabolize cellulose have gained prominence in recent years (Bhat and Bhat, 1997, Tomme *et al.*, 1995). Some examples of fungi used for the degradation of cellulose are *Fusarium sp.*, *Aspergillus sp.*, *Trichoderma sp.*, *Penicillium sp.*, etc (Gunatilake *et al.*, 2013)

METHODOLOGY

General experimental procedures: Sterilization of all glassware, media, and other solutions was carried out at 15 psi and 121°C using the Gemmy SA-300VL autoclave. Absorbance of test solutions and spore solutions were measured using the WPA S104 analogue UV-Vis spectrophotometer. Saw dust was ground and sieved (500 µm) prior to use in all experiments

Preparation of working cultures: Stock cultures of five species of fungi from the available OUSL fungal collection and another two species of soil fungi collected from OUSL, all of which have shown cellulolytic activity, were revived on yeast malt agar (YMA) and potato dextrose agar (PDA) media at 34.5 °C to prepare working cultures for the experiments. Cellulolytic ability of all the seven species was confirmed using the filter paper assay (FPA) technique. Identification of these fungi was attempted by studying the morphological characters.

Filter paper assay (FPA): In this test, the only available source of carbon for the microorganism was provided by cellulose on the filter paper. Spore solutions of different fungi sample (1.1 mL) were inoculated into test tubes which contained 10 mL of mineral salt medium with 1cm x 14 cm strip of filter paper. About half of the filter paper was allowed to project above the surface of the

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liquid. They were incubated at 34.5 °C and were examined daily. The degree of degradation of the filter paper was observed as a measure of the cellulolytic activity.

Pre-treatment of saw dust: Heat pre-treatment was carried out by heating the feedstock for 1 h in an oven at 160 °C. Steam pre-treatment was carried out by exposing the feedstock to steam in a large vessel for 1 h.

Determination Cellulolytic activity of selected fungi on saw dust: Mineral salt medium (8.00 mL) [containing (NH₄)₂SO₄ 6.0 g, KH₂PO₄ 1.0 g, K₂HPO₄ 1.0 g, MgSO₄ 0.1 g, CaCl₂ 0.1 g, yeast extract 0.5 g, FeCl₃.6H₂O 16.5 mg, ZnSO₄.7H₂O 0.18 mg, CuSO₄.5H₂O 0.16 mg, EDTA 20.1 mg and CoCl₂ 0.18mg in 1L of sterile water] was added to a flat bottle containing sieved saw dust (2.0 g) along with 2 ml of spore suspension having similar spore concentration (spore suspension was prepared taking into account a specific number of spores using a haemocytometer and adjusting the number of spores per unit volume in order to have, approximately, the same concentration in all spore suspensions) and incubated at room temperature (30 °C). This experiment was repeated with each of the seven (7) fungal cultures separately as well as in pairs (1 ml each of the two spore suspensions were added), using sieved saw dust under three different conditions [pre-treated (heat or steam) and non-pretreated] and subjected to incubation periods of 14, 21 and 28 days. Saw dust without fungus served as the control. After specific time duration the saw dust samples were analyzed for their reducing sugar contents as follows. Each sample was mixed with a small amount of distilled water, sonicated for 5 min, filtered through celite and the final volume of filtrate was adjusted to 10.00 ml. A sample (3.00 mL) of this filtrate was analyzed for reducing sugar content by dinitrosalicylic acid (DNS) method (Miller, 1959) as described below and the absorbance was measured at 575 nm. The concentration of reducing sugars in terms of D-glucose was then determined using the standard curve. The filtrates from each of the control were used as the blanks in measuring the absorbance. These experiments were carried out in duplicate.

Determination of the Glucose concentration using DNS method: From a stock solution of D-glucose (0.005 M), a series of dilutions (0.0006 to 0.0028 M) was prepared. Dinitrosalicylic acid (DNS) reagent (3.00 ml) was added to 3.00 mL portions of each of these solutions, mixed well and heated to 90 °C in order to develop the reddish orange/brown color. To stabilize the color, 40% potassium sodium tartarate buffer solution (1.00 ml) was then added to each of the hot solutions and rapidly cooled to room temperature in an ice bath. The blank solution was also prepared using water (3.00 ml) instead of glucose solution. A standard curve of *Absorbance vs Concentration* was constructed by measuring the absorbance of these solutions at a wavelength (λ) of 575 nm.

RESULTS AND DISCUSSION

Screening of fungal library for the cellulolytic activity using FPA resulted in selection of seven fungal cultures having potential for hydrolyzing cellulose. Total reducing sugar contents in terms of W/W percent of glucose are given in Table 1.

Table 1: Percentage of glucose (W/W) produced by the action of seven fungi on saw dust under different conditions.

Fungus	Concentration of sugars in terms of glucose (percent W/W)								
	Non-pretreated			Heat pre-treatment			Steam pre-treatment		
	14 days	21 days	28 days	14 days	21 days	28 days	14 days	21 days	28 days
Aspergillus sp. (A)	0.090	0.080	0.068	0.086	0.063	0.063	0.153	0.144	0.135
Monilia sp. (B)	0.054	-	-	0.090	0.068	0.063	0.135	0.108	0.100
Aspergillus sp. (C)	0.072	0.054	-	0.072	0.054	0.054	0.100	0.090	0.081
Aspergillus sp. (D)	-	-	-	0.054	0.054	0.063	0.081	0.072	0.072
Aspergillus sp. (E)	-	-	-	0.063	0.054	-	0.081	0.072	0.072
Unidentified sp. (F)	0.086	0.077	0.063	0.050	0.045	0.054	0.144	0.135	0.117
Aspergillus sp. (G)	0.109	0.095	0.072	0.090	0.072	-	0.162	0.144	0.144

It appeared that among the seven fungal cultures tested, two *Asperigillus* sp. (A) and (G) and, an unidentified fungal species (F), have produced relatively high yield of glucose from saw dust. It was also observed that the maximum sugar content is produced at 14 days duration. The reduction of sugar content after 14 days may be accounted for the use of soluble carbohydrates by the fungus for its metabolism.

Out of the 21 possible pairs of the seven fungi, three combinations (A+C, A+F and A+G) have shown marked increase in glucose content (See Table 2). It was found that incubation of pairs of fungi too have produced the maximum sugar content from steam pretreated saw dust in 14 days. Since the results indicate that there is a synergistic effect of fungi in hydrolysing naturally occurring complex carbohydrates, a consortium of microorganisms may be more effective in degradation of cellulose.

Table 2: Percentage of glucose (W/W) produced by the action of three combinations of two fungi species on saw dust under different conditions.

Fungus	Concentration of sugars in terms of glucose (percent W/W)								
	Non-pretreated			Heat pre-treatment			Steam pre-treatment		
	14 days	21 days	28 days	14 days	21 days	28 days	14 days	21 days	28 days
A+C	0.178	0.162	0.157	0.211	0.189	0.167	0.211	0.205	0.178
A+F	0.211	0.205	0.173	0.227	0.205	0.173	0.227	0.216	0.208
A+G	0.300	0.262	0.224	0.324	0.262	0.224	0.410	0.367	0.300

CONCLUSIONS/RECOMMENDATIONS

The foregoing results clearly show that steam pre-treated saw dust over 14 day incubation period produced the highest glucose content. The use of combination of fungi species (pairs in this case) has shown a further increase in cellulolytic activity, with the combination A+G providing the most promising results amongst them. The trend shown clearly indicates the potential for use of above fungi in converting cellulolytic bio mass (saw dust) to reducing sugars. Further investigations are needed to be carried out in terms of optimising the time duration and steam pre-treatment while other waste material also should be tested for the production of sugars.

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A STUDY OF PETROL VEHICLE EMISSION LEVELS IN SRI LANKA

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INTRODUCTION

Air pollution from vehicles especially petrol (gasoline) vehicles is a big environmental problem in urban areas worldwide. With urbanization, the number of vehicles on the road is gradually increasing mainly in developing countries. Some people personally suffer from air pollution on the road because they have to travel up and down every day at the traffic time on highways (Steven *et.al*, 2006).

Present Status of Petrol Vehicle Testing Process in Sri Lanka:

There are two vehicle emission testing agencies in Sri Lanka. They use four or five types of gas analyzers for testing. The mean emission levels reflect the state of the testing process. Mean Hydrocarbon and Carbon monoxide levels of each petrol vehicle category show that the testing process is in a satisfactory manner as a whole. All the data can be interpreted scientifically and according to the emission principles because of the accuracy of emission testing process. Some of these principles are;

Vehicles with catalytic converters have low CO and HC levels but high CO₂ levels.

Vehicles without catalytic converters have higher CO and HC levels but low CO₂ levels.

When current (2013) Sri Lankan petrol vehicle emission standards are compared with those of other countries, it can be seen that the other countries had lower standard levels even 10 to 15 years before. Sri Lanka is far back according to these figures (Table 1) (Asif Faiz *et al*, 1996).

Table 1 : Emission standard levels of petrol vehicles in selected countries

Country	Year	CO % (V/V)	HC (ppm)
USA	2004	1.7	1250
EU	2000	2.7	2000
Argentina	1999	2	3000
Australia	2000	2.1	2600
Brazil	1997	2	3000
Canada	1988	2.1	2500
EU	2006	1.0	1000
Sri Lanka	2013	6.0	9000

Therefore, this may be the time to establish suitable and stricter standards (with lower standard levels than present) for Sri Lanka. This research has given guidance for that.

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The other aspect is that Sri Lanka does not have NO_x standards. We also need NO_x standards because it is a powerful global warming gas. As per Euro 4 standards, Sri Lanka too needs standards for Particulate Matter (PM), Hydro carbons (HC), Nitrogen Oxide (NO_x), Sulphur Oxide (SO₂) and Carbon Monoxide (CO). Sri Lankan standards have only two parameters (HC & CO).

This study attempts to compare Sri Lankan emission standards with those of other countries. This research further proposes more suitable standards for petrol vehicles with suitable measuring tools and recommends necessary steps to improve Vehicle Emission Testing process in Sri Lanka.

METHODOLOGY

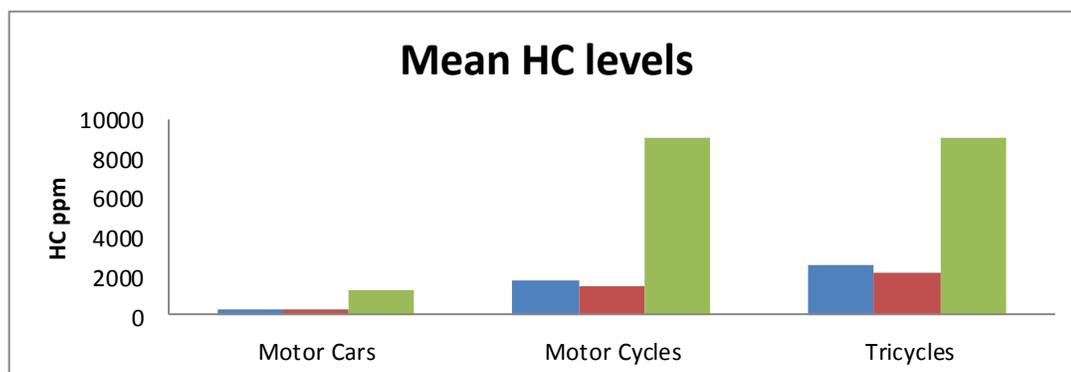
Vehicle emissions and their health effects, five gasoline vehicle emission parameters and the development of Sri Lankan standards were studied in this research. It further collected the data on petrol vehicle emission standards in developed and developing countries. Data were collected directly from emission certificates and from two agencies authorized to carry out emission testing in Sri Lanka. There were three categories of certificates. They were for motor cars, motor cycles and tricycles. This research analyzed 1200 local petrol emission certificates from Sri Lanka, obtained mean emission levels and compared them with emission standards in Sri Lanka. Out of 1200 certificates, each vehicle category had about 400 certificates. Three important emission levels (HC, CO, CO₂) were indicated in those certificates. These parameters were given in the certificates at two different rpm levels (Idle rpm and 2500 rpm) of the engine. So there were six emission levels for the analysis. The values given for those three parameters in the tested certificates were analyzed according to three types of petrol vehicles.

RESULTS AND DISCUSSION

Three types of emission test certificates were analyzed and mean emission levels were calculated. They are given below (Table 2).

Table 2– CO & CO₂ (% v/v) and HC (ppm v/v) of different vehicle types at idling and Accelerated

Vehicle Type	Idle HC	Idle CO	Idle CO ₂	Acc HC	Acc CO	AccCO ₂
Motor Cars	288.5	1.03	13.47	216.41	0.95	13.86
Motor Cycles	1748.11	2.48	7.08	1456.67	2.55	7.13
Tricycles	2492.05	2.67	7.59	2091.63	2.75	7.80



Fig

1 - HC levels of three types of vehicles with standards

Figure 1 shows the Hydrocarbon levels of the three types of petrol vehicles in January 2013. The main reason to low levels of HC emissions (288 – 216ppm) in petrol motor cars is that most of the cars contain catalytic converters. Catalytic converters convert Hydro Carbon into Carbon Dioxide. Motor cycles and Tricycles showed high levels of HC (1748 – 2492ppm) and this may be due to not having such converters in those vehicles. However, Sri Lankan emission standard levels for gasoline vehicles are very high as indicated in Table 1.

Therefore, these standards may not be useful or may not be helping to detect any pollution due to vehicular emissions even from a bad vehicle. Further, the tricycles and motor cycles owners may not take any interest in minimizing emissions as their levels are still within the permissible levels due to these high values indicated in the standards. Therefore, any rule on bad vehicles could be imposed only after reconsidering the existing standards.

Figure 2 shows the Carbon monoxide levels of the three types of gasoline vehicles in January 2013. The main reason for low levels of CO emission (1.3-0.95%) in gasoline motor cars may be the same reason that most of the cars contain catalytic converters. But motor cycles and tricycles have high levels of CO levels (2.48- 2.75%). Even though, the emission of CO is bad for the environment, it is not detected as present standard levels are very high (4.5 for cars and 6 for motor cycles and tricycles) and the findings do not reach even half of the standards.

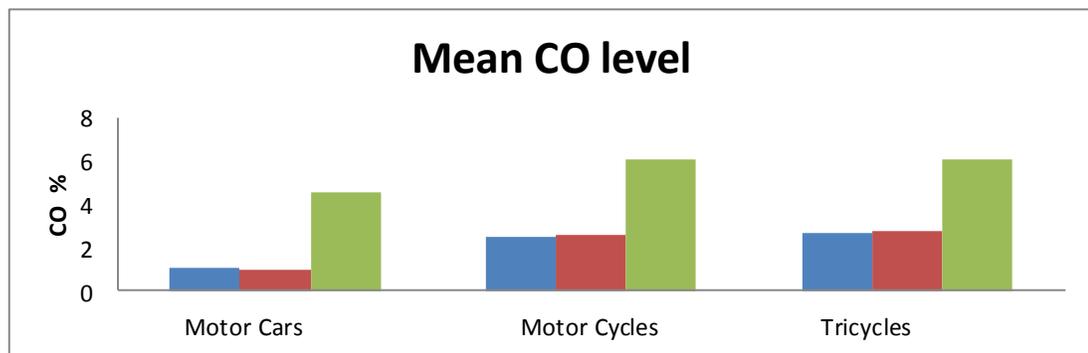


Fig 2 - CO levels of three types of vehicles with standards

Figure 3 shows the mean Carbon dioxide levels of the three types of gasoline vehicles in January 2013. The main reason for higher Carbon dioxide levels in gasoline motor cars is that most of the cars contain catalytic converters and they have converted Hydrocarbons and Carbon monoxide to Carbon dioxide. Carbon dioxide is not a vehicle emission parameter in Sri Lanka. The CO₂ levels in motor cycles and tricycles show a low level because they don't have any type of catalytic converters. Catalytic converter decreases CO and HC levels while increasing CO₂.

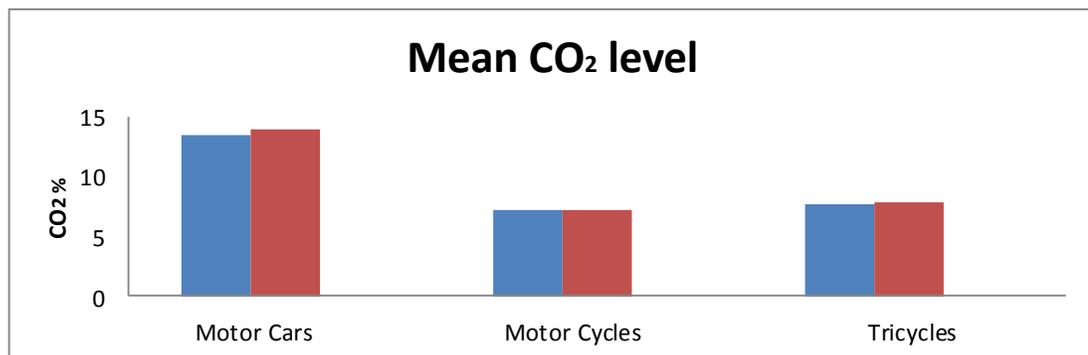


Fig. 3 - CO₂ levels (%) of three types without standards

RECOMMENDATIONS

Improving the emission standards: This can be implemented by improving present standards as proposed by this research to achieve better outcome of smoke test. As a developing country Sri Lanka should impose not only HC and CO, but also NO_x which is easily detectable and an important emission.

Using advanced technology: Chassis Dynamo meter should be used to get meaningful and accurate measurements. However it is difficult to introduce such advanced and expensive device instantly in Sri Lanka. So it is better to introduce a roller belt set with gas analyzer in order to get accurate measurements. Such roller sets can be manufactured locally. Such a set with a gas analyzer can be calibrated with a standard Chassis dynamo meter and emission measuring unit can be converted from percentage (%) or ppm to g/km

Improving the quality of testing process: It has been reported sometimes that emission certificates are issued without checking the vehicles. Such illegal offenses should be prevented by introducing strict legislations and random checking by police environment protection units using portable gas analyzers.

Implementing awareness programs: Most people think diesel emissions are worst but petrol emissions are not harmful. People should be educated regarding this. Vehicle repair technicians should be trained about vehicle emissions.

Use alternative methods: More environmentally friendly vehicles such as electric vehicles, solar powered vehicles and hybrid vehicles should be promoted. Using public transport system is a good step to minimize vehicular emissions as well as economic for the countries like Sri Lanka.

Using Portable Gas Analyzers: These can be introduced by the police environmental protection units for random checking of emission levels of the vehicles on the road. .

Implementing strategic environmental policy: Environmental protection police, Central Environmental Authority, Department of Motor Traffic and the Department of Environment should work together to minimize these issues.

Introducing Catalytic converters for brand new three wheelers and motor cycles: Based on the present study, the main reason to high emission levels in these vehicle types is lack of catalytic converters. Many types of catalytic converters have been designed to use as an accessory with three wheelers and motor cycles. Such converters can be fixed to outlet line of the engine and emission levels can be reduced. They should be promoted and introduced to the market. Catalytic converters should be compulsory for all petrol vehicle types in Sri Lanka.

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INVESTIGATION ON THE IMPORTANCE OF MAINTAINING PROPER TREATMENT PLANTS AT AUTOMOBILE SERVICE STATIONS

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INTRODUCTION

Automobile service stations play a very important role in maintaining vehicles and keeping them in good condition. Effluents from these service stations may cause air, water and soil pollution. On-site wastewater treatment is a prospective direction towards the reduction of pollution load before discharging. Some of the existing fuel pumps and fuel services stations are facilitated with car-washing and these places generate more polluted wastewater. The large car washing and service stations are compelled by the respective pollution control authorities to provide necessary treatment for the effluent water.

Normally in service centers, the chemical coagulant is used to remove solid particles and the cascade system is used to remove oil and grease. Alum is used as a chemical coagulant. Medium size oil trapping tanks, storage tanks and chemical tanks are established as a cascade system in well maintained automobile service centers. Then a large amount of grease and oil are removed in the oil trapping tank. Oil trapping tank and chemical tank are used to remove grease and oil in less maintained service centers. Storage tank can be seen in most of the service stations. Firstly wastewater comes to oil trapping tanks and then goes to the storage tank. The highest concentration of contaminants like sand and particles with high density are settled in storage tank sludge. The production of many of the Volatile Organic Carbon (VOCs) and metals are found in storage tank (Sauer and Tyler, 1992). This is an underground sump with a capacity of one day. Normally the capacity of this tank equal to the volume of wastewater disposed in a day.

In this reactor, it is expected to collect wastewater and to equalize in order to produce uniform wastewater prior to feeding to the main reactor. After that, wastewater comes to a chemical tank. Coagulants and flocculants should be added by using dosing pumps with an appropriate pH correction and the wastewater needs to be stirred using a mechanical stirrer. In this unit, the added coagulant destabilizes colloidal particles, hydrolyzes and then forms gelatinous floc that adsorbs most pollutants particularly organic pollutants (around 80%) and heavy metals such as Pb⁺ if present. After agitation the wastewater shall be detained for 1-2 hours for effective sludge drying beds (composed of gravel and fine sand on top of the gravel bed). The collected sludge will be dried and disposed. Next, remaining water is transferred to filters. Sand filters are used very frequently. Charcoal and activated carbon are also used in some service centers. Finally, treated water is added to the natural environment (Hammer, 2012).

A treatment plant that is used to treat wastewater effluent generated by automobile service stations, has a few necessary features such as, Oil separating tanks, Collection tank, Chemical mixing and coagulation tank, sedimentation tank and filters. Most of the auto mobile service stations have a treatment plant with all the features mentioned above. The treatment plant which follows all the steps mentioned above to treat wastewater effluent can be recognized as a Well Maintained Treatment Plant (WM). However, some service stations do not follow all the steps of

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the procedure can be categorized as a Less Maintained Treatment Plant (LM). The main objective of the present study was to find out whether there are any impacts on the environment due to the discharge of wastewater from automobile service stations.

METHODOLOGY

Six service stations from Dehiwala – Mt. Lavinia Urban Council (3 well maintained and 3 less maintained) and another six in the same manner from Kesbewa Urban Council in the Colombo district were selected for this study. Altogether 12 service stations were studied.

Effluent of well-maintained and less maintained service stations were analyzed for pH – potentiometer method, Electric conductivity (EC)- EC meter, Total Dissolved Solids (TDS) – TDS meter, Biochemical Oxygen Demand (BOD) – Winkler method, Chemical Oxygen Demand (COD) –Open reflux method, Oil and Grease – Hexane extraction method and Total Suspended Solids (TSS) – Oven dry method (Arnold, 2002). Statistical analysis was done using SPSS software (Version 16). Two paired test was done to find out the significant differences between two groups. The dilution plate method (Parkinson, 1971) was used for enumeration of soil microorganisms of soil in the area where treated wastewater is disposed. Determination of the social, environmental and economic effects of service stations and their wastewater were done using a questionnaire. Fifty persons whose residences are near the auto mobile service stations were selected for the questionnaire survey.

RESULTS AND DISCUSSION

The results for changes of Biochemical Oxygen Demand (BOD) (Fig 3.1), Chemical Oxygen Demand (COD) (Fig.3.2), Total Dissolved Solids (TDS) (Fig 3.3) and Oil & Grease (Fig 3.4) are given below. The values for BOD (sig=0.012, $P < 0.05$), COD (sig=0.003, $P < 0.05$), Oil and grease (sig = 0.015, $P < 0.05$) and TDS (sig=0.013, $P < 0.05$) of the effluent showed significant differences between well maintained (WM) and less maintained (LS) service stations, but no significant differences were recorded for pH and TSS. The average BOD value for less maintained treatment plants takes 6 times greater than the declared value (30 mg/l) by Central Environmental Authority (CEA). Recorded COD value for well-maintained service stations was around 60-200 mg/l and 215- 630 mg/l for less maintained service stations. Average COD value for less maintained treatment plants is 2 times of greater (250 mg/l) than the value declared by CEA. Around 4.0- 12 mg/l value for oil and grease recorded for well-maintained service stations and 8- 36 mg/l recorded for less maintained service stations. Oil and grease value for less maintained treatment plants takes 2 times greater than CEA stands (10 mg/l). Well maintained service stations recorded 28- 64 mg/l range for TSS and less maintained service stations recorded 56- 1172 mg/l. TSS value for less maintained treatment plants takes approximately 6 times greater than CEA stands (50 mg/l).

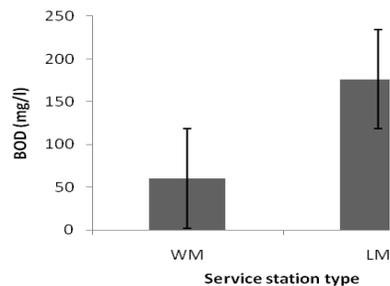


Fig.3.1 Change of BOD in WM & LM

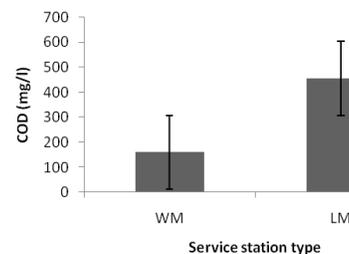


Fig 3.2- Change of COD in WM & LM

According to Fig.3.5, there was no significant difference between well maintained and less maintained service stations for bacterial colonies. The result of the questionnaire indicated that 32% have been affected due to the labor force of the service stations and nearly 22% of the people who work at sites reported that they are suffering from health problems. 20% of residents indicated that they have been affected by vehicles and customers who come to the stations. All (100%) said that they are affected by noise. Soil degradation (18%), disposed solid wastes (32%), and wastewater (36%) & water droplet (30%) are the other social and environmental effects by these stations.

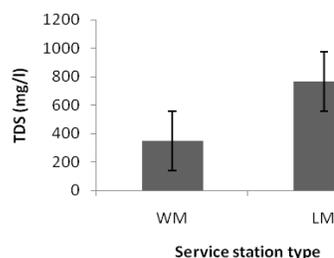


Fig 3.3- Change of TDS in WM & LM

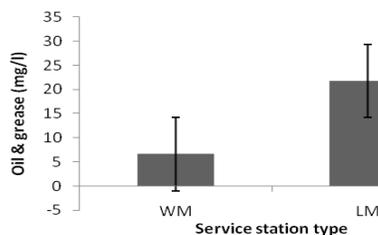


Fig 3.4-Change of Oil & grease in WM & LM

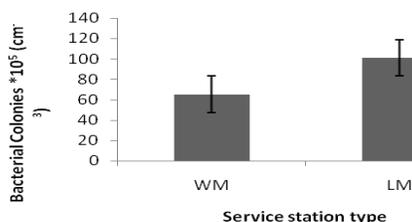


Fig 3.5 Change of Bacterial Colonies in soil in WM & LM

BOD indicates organic contaminants (biodegradable) present in a body of water. Diesel, emulsified oil, free oil and gasoline in wastewater contribute to higher levels of BOD (Yasinet. al, 2012). Shampoos and detergents used to wash vehicles also contribute to BOD. WM service centers use correct dosage of Alum and certain amount of organic contaminants are removed by Alum. Further, storage time of wastewater in WM automobile service centers is higher than that of LM service centers thus giving more time for settling with Alum. Therefore, less BOD value recorded for well-maintained service stations is justifiable. If BOD in effluent water is not controlled as in WM, aquatic bodies are in great trouble due to high demand for oxygen. COD in wastewater shows the presence of contaminants that are stable and not easily biodegradable (Bechetet al, 2006). Further, the high concentration of COD and BOD recorded in automobile wastewater might due to the use of chemical which are organic or non-organic that are oxygen demand (Akan, et al., 2008). Diesel, gasoline, oil emulsions, waste engine oil also contribute COD value in effluent water (Yasinet. al, 2012). The significantly different values reported in this study could be due to the contamination of above mentioned substances in LM service stations. It is obvious that if proper control for oil and grease is happening, the COD should be automatically reduced. Oils and grease are present in the wash water because mostly the vehicles have leaky engines and people also use to spray diesel or waste engine oil and sometimes kerosene on under carriage. Oil and water separators used in well maintained service stations are able to maintain less oil in effluent wastewater. However, as reported by Harrison & Wilson (1985), detergents surround oil droplets with a layer of detergent molecule to give them a water-soluble coating. Therefore, water/oil separators too may fail to keep values of oil and grease to 10 mg/L (National Environmental Act, No. 47 of 1980) in effluent due to the above effect. However, the results of

this study shows that reasonable control is happening with oil/water separators used in WM. Serious thought should be given to the control of oil and grease in service stations as it contributes to reduce oxygen in water bodies affecting aquatic life (Arnold, 2002). The dissolved solids do not settle in settling or grit removal chambers and make the wastewater turbid as well (Yasinet *al*, 2012). TDS can be removed in oil trap, collection tank, sedimentation tank and filtration tank. Therefore, TDS in WM service centers is always lower than LM service centers. Contamination of the soil by wastewater containing detergents, fuel, oil and grease discharged from service stations soil causes it to lose its useful properties such as fertility, water-holding capacity, permeability and binding capacity (Moorthiet.al, 2008). The results obtained in this study clearly show that the affected soil has a less number of bacterial colonies. Though there are no significant differences of bacterial colonies between WM and LM soils, this is something to be concerned with as reduced soil quality as indicated by the number of bacteria could affect the fertility of the soil. As reported by Nduka and Orisakwe, 2009, high heavy metal content, high BOD level, high EC & low pH have been recorded in potable water near automobile service stations. Therefore, it is clear that improper disposal affects people's immediate environment including human health. Based on the questionnaire survey, it is apparent that the literacy level of the people who maintain these places vary and this too could affect the use of correct procedures such as proper operation, correct dosage of Alum and detergents as well as having proper oil and water separators.

CONCLUSIONS/RECOMMENDATIONS

A significant difference has been recorded for BOD, COD, TDS and Oil and grease of the automobile effluent between WM and LM auto mobile service stations. Establishing and maintaining proper waste treatment plants for service stations should be made compulsory. No significant difference between WM & LM has been recorded for biological measurements. Noise is the main problem which is present due to the daily functioning of waste treatment plants at auto mobile service stations. Health problems, reduced soil quality, disposed solid wastes, wastewater, water droplets are other social and environmental effects of these stations.

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ANALYSIS OF CARBON: NITROGEN RATIO OF THE COMPOST PRODUCED USING MARKET WASTE

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INTRODUCTION

Solid waste management can be done in many ways. Among these methods composting is one way of recycling solid wastes which minimizes environmental pollution. Composting is a win-win solution in solid waste management. During this process, no environmental pollution occurs and at the same time the compost improves soil fertility. Vavuniya district is an agricultural area where nearly 65% of the families are engaged in farming. Thus they will be benefited by using this compost on their farm land. Good quality compost improves soil fertility and thereby increases the yield of the crops which eventually contributes to food security.

The Carbon: Nitrogen (C/N) ratio of compost is an important factor that determines whether the soil fertility has improved or deteriorated. Overall carbon/ nitrogen ratio between 25:1 and 30:1 was considered ideal for starting materials. If the ratio is below this range, N losses from the pile might be excessive; if the C/N ratio is too high, the relative decomposition slows down when the nitrogen is used up and some organisms die (Horan, 1995). The quality is determined by the waste materials that are added to the compost pit. Compost production and sales have been done at Vepankulam by UC (Urban Council) on a limited scale using solid wastes such as waste from vegetable market, and broken branches of trees found on the roads within the Urban Council limits. The objective of this study was to analyze the carbon/ nitrogen ratio of compost produced using vegetable market waste and the broken branches of trees to improve the quality of compost by adding other solid wastes.

METHODOLOGY

The investigation was conducted at the composting site at Vepankulam, Vavuniya every month. The organic waste materials were mainly vegetables and fruits as green material and broken branches of trees were the brown materials used for composting. The samples for analysis were collected from four different spots in each of eight pits from August to November, 2011. A representative compost sample was taken from the homogenized compost heap prepared during the period from May to August, 2011 for the chemical analysis. Sub-samples (250g) were taken from 4 different points of the compost heap (bottom, surface, side and centre). Organic carbon was determined by the Walkley and Black method, total nitrogen was estimated by the Kjeldahl procedure. Altogether 32 samples of compost at the Vepankulam site produced with different combinations of waste material were taken and analyzed for organic carbon and total nitrogen in the laboratory using Walkley and Black method and Kjeldahl process respectively.

RESULTS AND DISCUSSION

Carbon/ Nitrogen ratio of the compost produced at Vepankulam site is given in Table 1. The results reveal that the compost produced at this site was of high nitrogen content since they used organic waste materials such as vegetables and fruits as green material and broken branches of trees as brown materials for composting. BoMyeong and Rosales (1982) reported that green materials like green leaves and green vegetables used for composting were rich in nitrogen content. The high amount of nitrogen leads to unnecessary loss of nitrogen from the soil while this compost is added to the soil as soil amendment. The optimum C/N ratio of good quality compost is considered as 10-20:1 since compost within this range is unlikely to immobilize or deplete plant available nitrogen (Radovich, *et al.*, 1988). As the compost produced at this site is 7-8:1, the

C/N ratio should be increased by adding the waste material which is of high carbon content. In this district the solid waste of rice husk produced at rice mills and straw from paddy fields contain a high amount of carbon.

Table1: C,N and C/N ratio of the samples taken in different months.

Month	Carbon (%) by weight	Nitrogen (%) by weight	C/N ratio
August	8.59±0.17	1.1±0.53	8:1
September	9.12±0.11	1.34±0.061	7:1
October	8.76±0.14	1.08±0.56	7:1
November	7.83±0.11	0.98±0.46	8:1

Average of eight replicates ± standard error

Past studies (Seran, *et al.*, 2010) and the discussion had with the Research Officers at the adaptive research stations revealed that the yield of crop had been increased by 50% when good quality compost was added combining with inorganic fertilizer that was 50% of the inorganic fertilizer was substituted with compost.

CONCLUSIONS/RECOMMENDATIONS

Based on the study it can be concluded that the compost produced at Vepankulam site using market waste was of low C/N ratio as they were green vegetables and fruits which may be rich in nitrogen content. Hence, further studies to find out the correct proportion of different waste materials are an urgent need in order to produce good quality compost with appropriate Carbon/Nitrogen ratio.

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THE STUDY ON HETEROSIS IN THE F₁ HYBRID OF TWO LOCAL VARIETIES OF BRINJAL (*Solanum melongena* L.)

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INTRODUCTION

Brinjal (*Solanum melongena* L.), is one of the most popular and principal vegetable crops widely grown in subtropical and tropical countries, including Sri Lanka. In Sri Lanka, brinjal is one of the most popular local vegetables and is cultivated by farmers in fair quantities in hot and rainy seasons, when other vegetables are in short supply. Brinjal is practically the only vegetable that is available at an affordable price to the rural and urban poor and the daily sale of its produce serves as a ready source of cash income to the farmers for a period lasting 3-4 months. Brinjal, which is commonly known as eggplant is also known by several other names and a large number of varieties is grown in different countries. In our country it is well known as 'Katharikai' in Tamil and 'Buttu' in Sinhala.

The recommended varieties in the list in Sri Lanka are 'SM 164', 'Thinnavelly purple' and 'Lena hiri'. However, a local cultivar 'Palukamam purple' is famous in the Batticaloa district for its quality fruits which has high consumer acceptability. This variety is a locally adapted land race collected from 'Palukamam' village in the Batticaloa district. Plants are erect and tall; they bear large, long cylindrical shaped purple colored fruit, about 90-100g in weight. 'Mudduvilmuddi' is a traditional short duration variety from Jaffna with white colored, fleshy, and less seeded fruit. The average fruit weight is about 100-125g.

In spite of its popularity among small and resource- poor farmers in the Batticaloa district brinjal cultivation is often input intensive, especially in relation to insecticide and fungicide applications. Brinjal is prone to attack from insect pest and diseases which cause severe problems in its cultivation, making the fruits unsuitable for the market and unfit for human consumption. If a hybrid is to be accepted commercially, it must be superior to the cultivars presently grown. This superiority may be expressed in terms of total yields, early yield, nutritional quality, post harvest life, insect pest disease resistance, adaptability, etc. (Shafeeq *et al.*, 2006).

The high degree of heterosis in eggplants has been reported in several studies in world-wide literature (Monteiro, 1975; Dixit *et al.*, 1982; Singh and Kalda, 1989; Chadha *et al.*, 1990; Sousa, 1993). Most authors recommended the commercial use of eggplant hybrids because of heterosis for fruit yield traits (Monteiro, 1975). In view of the above facts, the aim of this study is to evaluate the desirable traits in the 'F₁ hybrid' so that an ideal type is evolved for economic production and to find whether the F₁ would possess the combination of all characteristics of economic importance.

METHODOLOGY

The experiment was conducted in the green house of the Department of Agricultural Biology, Faculty of Agriculture, Eastern University, Sri Lanka during the period January to June, 2013. The parent 'Palukamam purple' (female parent), 'Mudduvilmuddi' (male parent) and 'F₁ hybrid' of those varieties were used as experimental variables and arranged in CRD with six replications. The top soil was mixed with well rotted cow dung and red soil. This mixed soil was sterilized with sunlight for about 7 days by air tight polythene method to eliminate infection from soil borne pathogen. Subsequently the sterilized potting media was transferred to the pots. The 40 day old

seedlings of two parent and 'F₁ hybrid' were transplanted into the experimental pots. A liquid organic fertilizer named "Jewa Amirtha" was applied after two weeks from the transplanting to the time of the last harvest at two weeks intervals. Watering was done twice a day up to four weeks after transplanting and then every day up to the final harvest. Manual weeding was done twice a month.

Measurement & Observation

Data collection was initiated from the day of germination and continued up to the last harvest. Agronomically important parameters such as the date of first flowering, plant height at first flowering, date of first fruit formation, plant height at first fruit formation, weight, length and width of the fruits at first, second, third, fifth and eighth harvest were taken into consideration. In addition to these, shoot borer and mealy bug damages and qualitative characteristics of fruits were also assessed.

STATISTICAL ANALYSIS

Analysis of variance, using general linear model was used to analyze the data collected on yield, yield components and other agronomic characteristic and the mean was compared by using SAS statistical package.

RESULTS AND DISCUSSION

DAYS TAKEN TO FIRST FLOWERING AND FIRST FRUIT FORMATION

Early flowering and early maturity are desirable characters of plants (Sousa and Wilson, 1994). It was found that 'F₁ hybrid' and the parents '*Palukamam purple*' and '*Mudduvilmuddi*' had taken 45, 51.7 and 48 days respectively to initiate flowering and fruits were formed at 50, 60.6 and 53.3 days respectively after flowering (Table 1). Variety '*Mudduvilmuddi*' and the 'F₁ hybrid' showed no significant difference in the above parameters. However, significant differences were noticed between the 'F₁ hybrid' and female parent ('*Palukamam purple*'). Days to flowering and fruit formation were respectively 4.9 and 7.0 earlier than the mid parent values. This is a positive indication of genetic advancement and a desired characteristic in breeding.

Table 1: Days taken to first flowering and first fruit formation

Treatment	Mean value of days to first flowering	Mean value of days to first fruit formation
' <i>Palukamam purple</i> ' (pp)	51.7 ^{a*}	60.6 ^a
' <i>Mudduvilmuddi</i> ' (mm)	48.0 ^b	53.3 ^b
'F ₁ hybrid' (pp x mm)	45.0 ^b	50.0 ^b
Mid parent value	49.9	57.0

*Figures followed by same letters in each column do not differ significantly at p=0.05, base in DMRT.

PLANT HEIGHT AT FIRST FLOWERING AND FIRST FRUIT FORMATION

Significant differences in plant height were noticed among parents and their 'F₁ hybrid' at first flowering and first fruit formation. The male parent '*Mudduvilmuddi*' had the lowest value of plant height compare to the female parent '*Palukamam purple*' and 'F₁ hybrid'. However, the

'F₁ hybrid' showed the intermediate effect of the parents (Table 2), which would have been due to gene dispersion on the parents, and could be considered an additive gene effect.

Table 2: Plant height at first flowering and first fruit formation

Treatment	Mean value of height at first flowering (cm)	Mean value of height at first fruit formation (cm)
'Palukamam purple'(pp)	49.9 ^{a*}	60.3 ^a
'Mudduvilmuddi' (mm)	25.3 ^c	35.0 ^c
'F ₁ hybrid' (pp x mm)	38.7 ^b	41.3 ^b
Mid parent value	37.6	47.7

*Figures followed by same letters in each column do not differ significantly at p=0.05, base in DMRT Weight, length and width of pod

In this investigation, a remarkable increase in pod weight was observed in the 'F₁ generation' (Fig. 3) of the cross between 'Palukamam purple' (Fig. 1) and 'Mudduvilmuddi' (Fig. 2) and significant differences were noticed between the parents and their F₁ hybrid at p= 0.05. It was also more than the better parent. The calculated increase of fruit weight up to 71 percent over mid parent value was obtained from the fruit weight in the second harvest (Table 3) and can be possibly attributed to the effect of the combination of dominant genes together in the hybrid (dominance hypothesis). When the yield characteristics are used as assessment criteria, it is desirable that the heterosis and heterobeltiosis level, shown in the hybrid combinations, be as high as possible. Mean fruit weight and mean weight of early fruit are an exception since very high heterosis and/or heterobeltiosis values may lead to fruit much heavier than those established by the market gardeners (Sousa and Wilson, 1994).

Table 3: Weight of fruits at first, second, third, fifth and eighth harvests

Treatment	Mean weight of the fruit (g)				
	1 st	2 nd	3 rd	5 th	8 th
pp	99.7 ^{b*}	96.0 ^b	89.7 ^b	72.7 ^c	79.1 ^b
mm	115.3 ^b	119.0 ^b	165.0 ^{ab}	93.7 ^b	81.0 ^b
ppX mm	137.6 ^a	183.6 ^a	121.3 ^a	120.0 ^a	108.0 ^a
Mid parent value	107.5	107.5	127.3	83.2	80.1

*Figures followed by same letters in each column do not differ significantly at $p=0.05$, based on DMRT



Fig 1. Palukamam purple (pp) Fig 2. Mudduvilmuddi (mm) Fig 3. F₁ hybrids (pp X mm)

The variety ‘*Palukamam purple*’ had the longest pod, followed by ‘F₁ hybrid’ and ‘*Mudduvilmuddi*’ (Table 4). The ‘F₁ hybrid’ produced intermediate fruit length and fruit length intermediate between parents will have been due to gene dispersion in the parents (additive gene effect). Several workers have reported that fruit length is influenced by the additive gene effect (Peter and Singh, 1973; Vadivel and Bapu 1990) High heritability and high genetic gain have also been observed for fruit length by many workers (Vadivel and Bapu 1990).

Table 4: The length of fruits at first, second, third, fifth and eighth harvests

Treatment	Mean length of the fruit (cm)				
	1 st	2 nd	3 rd	5 th	8 th
pp	21.4 ^a *	21.0 ^a	19.7 ^a	17.3 ^a	17.5 ^a
mm	10.6 ^c	11.0 ^c	11.4 ^c	10.6 ^c	9.7 ^c
ppX mm	15.8 ^b	14.1 ^b	15.9 ^b	14.4 ^b	15.0 ^b
Mid parent value	16.0	16.0	15.6	13.9	13.6

*Figures followed by same letters in each column do not differ significantly at $p=0.05$, based on DMRT

Also, the male parent ‘*Mudduvilmuddi*’ and their hybrid had the highest pod width at 1st, 2nd and 3rd harvest and the mean values are similar in the 5th and 8th harvest. Meanwhile, the other parent ‘*Palukamam purple*’ had the lowest fruit width. ‘F₁ hybrid’ did not exceed their better parent but exceeded the mid parent value in fruit width (Table 5).

Table 5: Width of fruits at first, second, third, fifth and eighth harvests

Treatment	Mean width of the fruit (cm)				
	1 st	2 nd	3 rd	5 th	8 th
pp	13.5 ^{b*}	13.1 ^b	15.3 ^b	13.7 ^c	12.7 ^b
mm	25.7 ^a	24.7 ^a	21.0 ^a	22.4 ^a	20.0 ^a
ppX mm	25.4 ^a	22.9 ^a	20.7 ^a	18.4 ^b	15.2 ^{ab}
Mid parent value	19.6	18.9	19.1	18.1	16.4

*Figures followed by same letters in each column do not differ significantly at $p=0.05$, based on DMRT

Other characteristics under study

The 'F₁ hybrid' produced light purple with white shaded colored and elongated fruits with intermediate fruit length (Fig.3). A mild attack of Mealy bug insect was observed in the F₁ plant but shoots and fruit borer damage was not noted.

CONCLUSIONS

The important features of this study are to evaluate heterotic effect of 'F₁ hybrid' of the crosses of two local varieties for many characteristics of economic importance. The study reveals that heterotic effects can be positively exploited for many agronomic characteristics of economic importance in brinjal and further more heterobeltiosis is clearly manifested in fruit weight. This is well applicable when parents of diverse origin are used in hybridization of brinjal.

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EFFECTS OF SELECTED ORGANIC SOURCES ON THE VEGETATIVE GROWTH OF DIFFERENT MAIZE (*Zea mays* L.) VARIETIES IN SANDY REGOSOL OF BATTICALOA DISTRICT

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INTRODUCTION

The popularity of organic cultivation is increasing in Sri Lanka due to attitude change of the people towards their health and environmental aspects. The increased demand for organically grown products also induces the scientists to disseminate the knowledge to the farmers. Maize is a popular coarse grain crop in Sri Lanka, grown in the second highest extent of land next to rice. Maize is used as a raw material in various industries and the demand is increasing continuously. Maize has demand in foreign countries and there are possibilities to export maize from Sri Lanka. In this context, organically produced maize would be more attractive to foreign consumers and earn more foreign exchange. As such this research was carried out to evaluate the effects of selected organic sources on the growth of traditional and hybrid maize varieties and to select best manure for organic maize cultivation in the sandy regosol of Batticaloa district.

METHODOLOGY

A field experiment was conducted at the crop farm, Eastern University, Sri Lanka during Yala 2013. Varieties of maize and selected organic sources were arranged in two factor factorial randomized complete block design (RCBD) with three replications. Each replication contained twenty plants and an experimental unit consisted of one plant.

Treatments:

- F1V1 – Var. *Bhadra* + Recommended¹ dosage of inorganic fertilizers (Control)
- F1V2 – Var. *Pacific* 984 + Recommended dosage of inorganic fertilizers (Control)
- F2V1 - *Bhadra* + Cowdung at the rate of 20 t ha⁻¹
- F2V2 - *Pacific* 984 + Cowdung at the rate of 20 t ha⁻¹
- F3V1 – *Bhadra* + Compost at the rate of 20 t ha⁻¹
- F3V2 – *Pacific* 984 + Compost at the rate of 20 t ha⁻¹
- F4V1 – *Bhadra* + Glyricidia (*Gliricidia sepium*) fresh leaves at the rate of 20 t ha⁻¹
- F4V2 – *Pacific* 984 + Glyricidia fresh leaves at the rate of 20 t ha⁻¹
- F5V1 – *Bhadra* + Liquid organic mixture once a week
- F5V2 – *Pacific* 984 + Liquid organic mixture once a week

All the organic manures were applied as basal except liquid organic mixture. Liquid organic mixture (*Jeewamirta*) was prepared with the ingredients at the rate of 10kg of dung and 10 L of urine from indigenous cow, 2kg of Jaggery, 2 kg of pulse powder and a handful of farm soil (ingredients for one acre). All six ingredients were mixed in a plastic barrel and stirred well. Then the barrel was covered with a gunny mat and placed under shade. The mixture was stirred clockwise twice a day in order to accelerate microbial activities. The prepared *Jeewamirta* was applied after three days of fermentation. *Jeewamirta* was diluted 10 times with water before application. Plants were arranged at a spacing of 60cm x 30cm and one plant per hill. All other management practices were followed uniformly. Destructive sampling method was practiced and

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samples were selected randomly for measurements. Measurements were taken one month after planting (vegetative stage). Growth parameters viz. plant height (cm), leaf area (cm²), and plant biomass (g) were measured. Analysis of variance (ANOVA) was performed to determine significant differences among treatments ($p < 0.05$).

RESULTS AND DISCUSSION

Different organic manures influenced the growth of maize varieties significantly ($p < 0.05$). The interactive effect of the maize varieties and manures on the measured growth parameters was not significant ($p < 0.05$) (Table 1). In all measured growth parameters viz. plant height, leaf area and biomass, maize varieties grown in fertilizer treatments F1 and F4 performed significantly ($p < 0.05$) higher than other treatments. Further, there were no significant ($p < 0.05$) differences between treatments F1 and F4 in measured growth parameters.

Table 1: Effect of different organic inputs on the growth of maize varieties at one month after planting

Fertilizers	Variety	Plant height (cm)	Leaf area (cm ²)	Biomass (g)
F1	V1	119.67 ^a	2,694.82 ^a	49.17 ^a
	V2	108.67 ^{ab}	1,746.30 ^{ab}	31.96 ^{ab}
F2	V1	66.83 ^c	631.79 ^{bc}	4.00 ^c
	V2	73.00 ^c	727.62 ^{bc}	5.18 ^c
F3	V1	80.00b ^c	862.94 ^{bc}	9.49 ^{bc}
	V2	72.00 ^c	720.78 ^{bc}	12.92 ^{bc}
F4	V1	113.50 ^a	2,467.04 ^a	45.92 ^a
	V2	118.43 ^a	2,776.37 ^a	55.96 ^a
F5	V1	67.00 ^c	459.98 ^{bc}	6.59 ^c
	V2	59.03 ^c	323.99 ^c	5.57 ^c
P value	Fertilizers	0.000	0.000	0.000
	Varieties	0.455	0.345	0.886
	Interaction	0.568	0.223	0.519
F value		*	*	*

Value represents mean of three replicates. F test: * represents significant at $p < 0.05$

Means followed by the same letter in each column are not significantly different according to DMRT at 5 % level

In this experiment, Glyricidia leaves application significantly increased the vegetative growth of maize varieties than other organic manures. The plants treated with Glyricidia leaves showed almost equal growth to plants that received recommended dosage of inorganic fertilizers. Glyricidia is an excellent organic fertilizer (Liyanage, 1987). Several studies revealed that, addition of Glyricidia leaves as green manure increases growth and yield of many crops (Kidd and Taogaga, 1985; Budelman, 1989 and Gonzal and Raros, 1988).

Nitrogen influences the vegetative growth of plants. Boroujerdnia and Ansari, (2007), pointed out that, application of nitrogen fertilizer stimulates vegetative growth by increasing the number of leaves and leaf area (LA). Glyricidia consists of high amount of nitrogen. Patil (1989) reported that 1 tonne dry weight of Glyricidia leaves was equivalent to 27 kg Nitrogen. Green manures release nitrogen quickly and have low C:N ratio. The higher nitrogen content and rate of release of Glyricidia leaves would have increased the vegetative growth of maize plant. It could be the reason for highest LA produced by the Glyricidia leaves treated plants. LA is the most important photosynthesis acceptor and varies among cultivation practices (Bavec *et al.*, 2007). LA greatly influences the rate of photosynthesis and accumulation of plant biomass. As such, in this experiment, biomass production was in accordance with the trend of variances for leaf area and highest biomass was produced by maize varieties subjected to treatment F4. Performance of Var. *Pacific 984* was higher in Glyricidia treatment than var. *Bhadra*. It may be due to hybrid vigour of this variety.

CONCLUSION

In this experiment, maize varieties received fresh Glyricidia leaves as organic manure showed higher plant height, leaf area and biomass accumulation. In addition, there were no significant differences between the plants treated with fresh Glyricidia leaves and recommended dosage of inorganic fertilizers in measured vegetative growth parameters. Therefore, the results of this study revealed that fresh Glyricidia leaves at the rate of 20 t ha⁻¹ can increase the vegetative growth of maize which is equivalent to recommended dosage of inorganic fertilizers in the sandy regosol.

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PRELIMINARY STUDIES ON INDUCING HERBICIDE RESISTANCE IN SRI LANKAN RICE VARIETIES USING CHEMICAL MUTAGENS, NaN_3 AND EMS

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INTRODUCTION

Weeds are a source of biotic stresses in crop systems including rice. Weeds decrease the yield, increase production costs, and contribute to income risk in rice cultivation (Rao & Nagamani, 2007). Therefore, weed control is an essential component of profitable rice production. Rice weeds can be controlled mechanically, chemically (with herbicides) or culturally. A combined approach including herbicides is more economical and even more effective than reliance solely on mechanical and cultural control practices. Many weed species present in rice fields in Sri Lanka are difficult to control, thus application of a pre-emergence broad-spectrum herbicide, glyphosate (round-up) is recommended. Glyphosate targets monocotyledons and dicotyledonous weeds, permitting less herbicide use in terms of amount and number of application. However, glyphosate causes damages to cultivated rice as well ([Labrada, 2007](#); [Davis, Scott, Norswothy, Smith 2009](#)).

Inducing herbicide resistance (HR) into rice is a new means to confer selectivity and enhance crop safety and production. Herbicide Resistant crops provide additional crop choice, enabling implementation of alternate weed management strategies to target specific weeds while maintaining crop sequences. Therefore, it is believed that inclusion of an HR crop in a cropping program along with a range of weed management approaches can ensure control of hard-to-control weeds (Beckie *et al.*, 2006). The discovery of HR weeds in early 1970s triggered an interest on developing HR crops using crop breeding techniques. As a result, Imidazolinone-resistant rice was developed through chemically induced seed mutagenesis with Ethyl Methyl Sulphonate (EMS) (Gealy *et al.*, 2003; Tan *et al.*, 2005). Commercial development is underway for EMS induced glufosinate-resistant rice (Lang and Buu, 2007). The mutagen Sodium Azide (NaN_3) has also been used to produce rice mutants for the enhancement of agronomic traits (Nakata *et al.*, 2008).

In Sri Lanka, there were a limited number of reports available on the induction of HR in rice varieties and at present, only a study conducted by Weerakoon *et al.* (2013) reported naturally existing inbred and traditional HR rice varieties in Sri Lanka. In the present study attempts were made to induce HR against glyphosate in 24 cultivated rice varieties (inbred and traditional) *via* mutagenesis through chemical mutagens, Sodium Azide (NaN_3) and Ethyl Methyl Sulphonate (EMS) to evaluate the mutagenic effect of these chemicals in inducing herbicide resistance. This study is an extension of the previous study on the natural herb resistance of traditional and inbred-cultivated rice varieties in Sri Lanka (Weerakoon *et al.*, 2013).

METHODOLOGY

Twenty four rice varieties were selected for the study. Six traditionally cultivated varieties (*Kalu Heenati*, *Sudu Heenati*, *Suwadal*, *Suduru Samba*, *Pachchaperumal* and *Murungakayan*) and eighteen inbred cultivated varieties (Bg94-1, Bg250, Bg300, Bg304, Bg305, Bg352, Bg357, Bg358, Bg359, Bg360, Bg366, Bg379-2, Bg403, Bg406, Ld365, At362, At308, Bw364) were obtained from Rice Research Institutes (RRDI) at *Batalagoda*, *Ambalanthota*, *Bombuwela* and *Labuduwa*, Sri Lanka. These varieties were maintained in a greenhouse at the Open University of

Sri Lanka. Randomized Complete Block Design (RCBD) was used in each treatment with three replicates.

Method 1 – Mutation Studies using NaN_3

The seeds of each variety were exposed to NaN_3 at 1.5 mmol l^{-1} , 3.0 mmol l^{-1} and 6.0 mmol l^{-1} concentrations for a day and allowed to germinate. Germinated rice seedlings (height *ca.* 4.0cm) were immersed in Glyphosate solutions with two different concentrations, 0.25 g l^{-1} and 0.5 g l^{-1} for 4 days. Control treatment was carried out without Glyphosate. All seedlings were subsequently transferred to soil medium (sterilized mud) and allowed to grow, and eight agromorphological characters (Table 1) were measured / observed.

Dead plants were considered as susceptible to the herbicide. The plants that survived and remained green (but did not grow) were considered as tolerant to the herbicide and the surviving plants with a substantial growth were considered as resistant to the herbicide. For each rice variety, number of resistant plants and percentage resistance was calculated. The percentage (%) of resistance was calculated using the following equation.

$$\text{Percentage resistance (\%)} = \left(\frac{\text{Number of resistant seedlings in a variety}}{\text{Total number of seedlings grown in the same variety}} \right) \times 100\%$$

The percentage of $\geq 40\%$ was chosen arbitrarily and considered as an indicator of glyphosate-resistance of mutated plants (Weerakoon, Somaratne, Wijeratne, Ekanayaka 2013).

Method 2 – Mutation Studies using EMS

The seeds of each rice variety were exposed to EMS at 2.5 mmol l^{-1} and 4.5 mmol l^{-1} concentrations for a day and the same steps described in Method 1 were followed.

Statistical analysis

Descriptive statistics were performed on the data set (mean, standard deviation). The GLM (General Linear Models) was used to test the interactions of factors (rice variety, NaN_3/EMS and glyphosate concentrations) on agromorphological characters. Since there were no significant interactions among the factors, One-way-analysis of variance (ANOVA) was performed on agromorphological characters. All statistical analyses were carried out using SAS Version 9.2 (SAS, 2008).

RESULTS AND DISCUSSION

Compared to the previous study (Weerakoon *et al.*, 2013), a higher percentage of resistant plants (a large number of varieties) resulted in 0.25 g l^{-1} glyphosate concentration. However, at 0.5 g l^{-1} glyphosate concentration caused a reduction in the percentages of resistance in rice plants and it may be due to inhibition of seed germination. Mutation study with NaN_3 revealed that four rice varieties (Bg300, Bg379-2, Bg403 and Bw364) were resistant to 0.25 g l^{-1} glyphosate concentration after mutation with NaN_3 (1.5 mmol l^{-1}) and there were three (Bg252, Bg359, Bg406) resistant varieties when mutated with 3.0 mmol l^{-1} NaN_3 (Fig 1 A and B) whereas 6.0 mmol l^{-1} concentration of NaN_3 seems to be too toxic and even the seeds had not germinated. Out of selected rice varieties, *Sudu heenati* and Bw364 showed resistance to 0.25 g l^{-1} glyphosate concentration after mutating with 2.5 mmol l^{-1} EMS and when increased, the EMS concentration up to 4.5 mmol l^{-1} , Bg300, Bg359, Bg304, Bg403, Bw364, *Suduru Samba*, *Murungakayan* were resistant to glyphosate. (Fig 2 A and B)

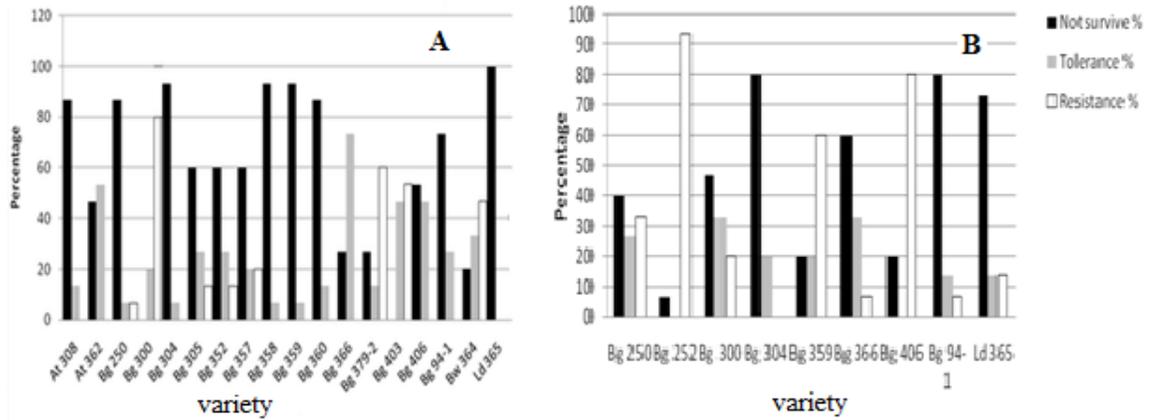


Fig 1: Glyphosate Resistance/Tolerance of rice varieties exposed to NaN₃
 (A) 1.5 mmol l⁻¹ of NaN₃; (B) 3.0 mmol l⁻¹ of NaN₃

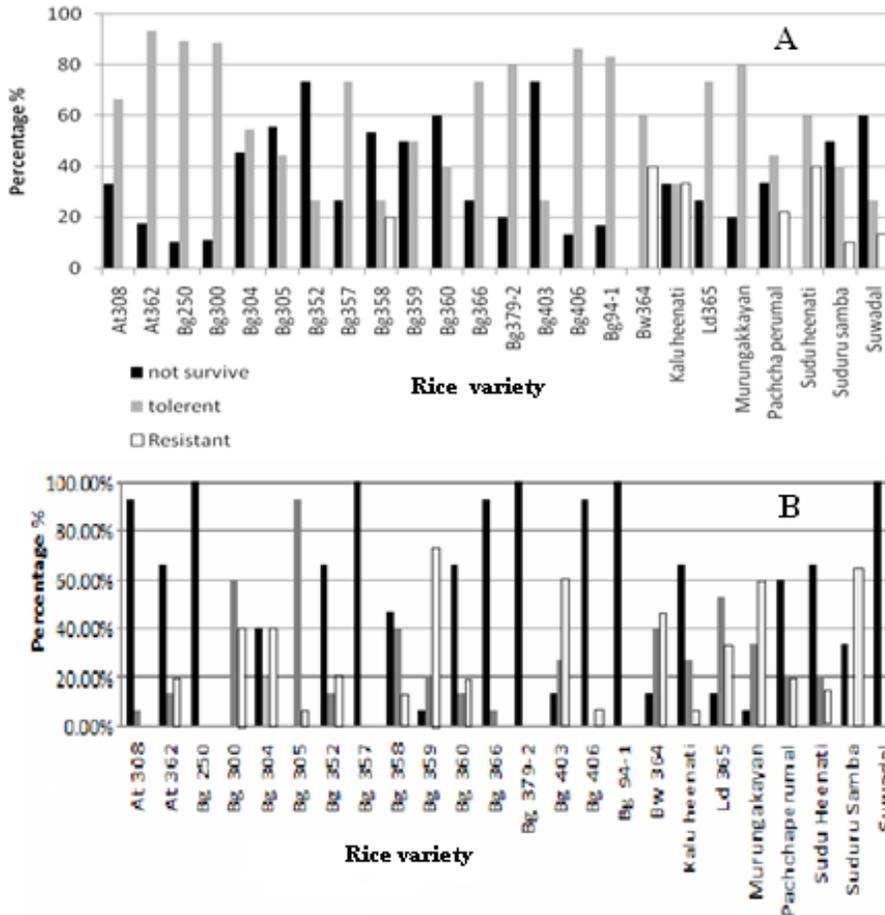


Fig 2:
 Glyphosate

Resistance/Tolerance of rice varieties exposed to EMS.

(A) 2.5 mmol l⁻¹ of EMS; (B) 4.5 mmol l⁻¹ of EMS.

A combined ANOVA (results not presented) revealed that all main effects (rice variety, NaN_3 /EMS and glyphosate concentrations) were not statistically significant ($p \geq 0.05$). Table 1 shows, all agro-morphological characters have no statistically significant differences between NaN_3 mediated-mutated rice plants and non-mutated rice plants under treatment at 0.25 g l^{-1} glyphosate. However, statistically significant differences were observed between EMS mediated-mutated plants and non-mutated plants under treatment at 0.25 g l^{-1} glyphosate (except germination time and flowering time). Similar observations were made by Benjavad, Talebi, Shahrokhifar (2012) with EMS mediated-mutated Malaysian rice.

CONCLUSIONS/RECOMMENDATIONS

Increasing NaN_3 and glyphosate concentrations have a negative effect on agro-morphological characters of rice varieties. Comparatively, EMS treatments resulted in higher percentage of resistance than that of NaN_3 . Further, a considerable yield penalty and stunting trends in agro-morphological characters was observed in NaN_3 treated plants. Both 1.5 and 3.0 mmol l^{-1} of NaN_3 and 4.5 mmol l^{-1} of EMS seem to be most suitable chemical concentrations for mutagenic purpose in inducing HR in rice. However, the dose dependent mutagenic efficiency of NaN_3 and EMS need to be further investigated. In addition, mutated rice varieties need to be evaluated for the stability of their HR for several generations (second generation is being evaluated). Mutated rice varieties with high glyphosate resistance have a higher candidacy in rice breeding programs as well as could lead to develop HR rice varieties in future

Table 1: Summary of ANOVA performed on the agro-morphological characters with respect to different concentrations of EMS and NaN_3 . The analysis includes HR resistant plants only.

Source	Sum of Squares	df	Mean Square	F	Significance
EMS treatments					
Germination time	0.03	2	0.05	0.30	NS
Height	9185.00	2	4592.50	16.67	S
Number of leaves/plant	149.43	2	74.72	15.52	S
Leaf width	267.16	2	133.58	8.18	S
Leaf length	2220.20	2	1110.10	7.80	S
Flowering time	1041.44	2	520.72	1.45	NS
Panicle length	2580.56	2	1290.28	39.48	S
Number of seeds/plant	11934.44	2	5967.22	36.89	S

NaN_3 treatments

(S = Significant at $p \leq 0.05$; NS = Not significant at $p \leq 0.05$)

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APPLICABILITY OF THE USE OF AEROPONIC SYSTEM AND SILICON SUPPLEMENTATION ON GROWTH AND THE FLORICULTURAL QUALITY TRAITS OF *Dendrobium* sp.

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INTRODUCTION

Floriculture industry in Sri Lanka is a profitable industry earning about 25% annual export income. *Dendrobium* sp (Orchidaceae) is the most 'in demand' cut flower in the export and local market due to its vivid and variable flower colouration. However, the production of quality flower is the major obstacle faced by local growers in Sri Lanka.

However, no research has been carried out to improve the floricultural quality and reduce diseases of *Dendrobium* plant/flower using non- hazardous methods. Hence, this research was focused on improving the floricultural quality of flowers using abiotic elicitor, 'Silicon'. The potential benefits of silicon nutrition in plants have been extensively studied by several scientists in the world. Some of these include the enhancement of growth and yield, improvement of mechanical properties, reduction of transpiration, resistance to metal toxicities and suppression of fungal and bacterial diseases.

The recent research findings indicates that silicon supplementation has improved the quality of Gerbera (Savvas *et al.*, 2002), Roses (Ehret *et al.*, 2005), Helianthus (Kamenidou *et al.*, 2008), Sunflower and Zinnia (Kamenidou *et al.*, 2008, 2009).

The present research was carried out to investigate the effects of silicon supplementation and application time on growth parameters (stem length, leaf length and number of leaves), and some floricultural quality traits of flowers (days for anthesis, number of flowers per spike, flower size, length and diameter of spike) of *Dendrobium* orchids. Practicality of growing orchid plants in newly developed aeroponics system was also tested with application of different levels of soluble silicon.

METHODOLOGY

Plant material

Healthy, mature, twelve month old, tissue cultured, *Dendrobium* plants (*cv. Kai brownderby-TDC-23*, and *cv. Sonia*) bought from the orchid nursery at the Department of Agriculture, National Botanical gardens, Peradeniya were used for the experiments.

Plants were planted in clay pots containing charcoal and tile pieces. These were kept in a mesh house at the Open University of SL, Nawala. The mesh house environment provided the required 50% shade by shade nets and misting was done to maintain the required temperature and high humidity levels. The recommended NPK (20: 20: 20) levels of fertilizer was provided twice weekly.

1. Preharvest application of Silicon supplementation

Three sets of *Dendrobium* plants, each containing 12 plants were used for this study. Silicon supplements were provided by applying sodium silicate (Sigma Aldrich inc. USA) as a foliar spray (5ml of solution as a fine mist) using a 1 L spraying bottle. One set of 12 plants were treated with sodium silicate (100 mgL⁻¹) at weekly intervals. The second set of 12 plants were

treated with the same concentration of sodium silicate (100 mgL^{-1}) but applied at two week intervals. The third set of 12 plants was sprayed with water and maintained as the control.

1.1. Effect of silicon supplementation on growth parameters

The growth parameters; stem length, leaf length and number of leaves were measured in *Dendrobium* plants treated with 100 mg/L Silicon at weekly and bi-weekly intervals and compared with that of control plants. The stem length was measured from the base of the plant at the soil surface to the apex or tallest point of the plant. Leaf length was measured from leaf base to apex in the third leaf. An average value for each of the above parameters was calculated per treatment every month for 14 consecutive months.

1.2 Effect of Silicon supplementation on flower quality traits

Some postharvest flower quality parameters: Days for initiation of buds, flowers, number of flowers per spike, flower size, spike length, spike diameter were evaluated for the plants treated with silicon and non treated control plants by recording the measurements throughout the period..

1.3 Levels of silicon in silicon treated plants

Analysis of molybdate reactive silica (SiO_2) by molibdosilicate method using spectrometry (Clesceri *et al.*, 1998)

The amount of silicon absorbed by the leaves and stems was analyzed in plants treated with different levels of sodium silicate and untreated controls, using spectrophotometer.

HCl (0.5 cm^3) and ammonium molybdate solution (1.0 cm^3) were added to 25.0 cm^3 of sample solution. The solution was mixed thoroughly and was allowed to stand for 5 – 10 minutes. Then Oxalic acid (1.0 cm^3) was added to the same solution and was mixed thoroughly. The absorbance of the solution was obtained at 410nm after 2 min. (before 15 min.), measuring the time from the addition of oxalic acid solution. Calibration standard solutions in the range of 4-12 ppm and the blank (distilled water) were prepared in the same manner and the absorbance was measured.

When dissolved in diluted HCl , sodium silicate forms silicic acid which is a gelatinous precipitate. The silicic acid precipitate was filtered and washed with distilled water in order to remove any Na^+ that might be adsorbed on to the precipitate; silicic acid was then dissolved in excess KOH to form potassium silicate.

(2) Effect of silicon supplementation on orchids cultivated in Aeroponics system

18 month old *Dendrobium* sp. (*cv. Sonia.*) was transplanted in a aeroponics system as illustrated in Fig 01. Eight plants were put into net pots incorporating charcoal pieces. Fertilizer (Standard NPK (20,20,20) was sprayed as a mist into boxes every day for a period of 05 min using pipe systems and electric pump designed as follows. Three boxes were connected to the nutrient tank and the excess nutrient solution was recycled.

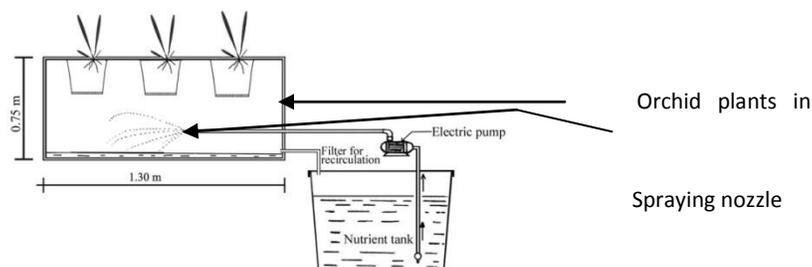


Fig 01. Newly designed aeroponics system for cultivating Orchids

Treatment was given at 2 week intervals. Each box contained 08 plants and plants in Box 01 was provided with 50 mg/L of sodium silicate and Box 02 with 100 mg/L of sodium silicate. Box 03 was sprayed with water (control).

RESULTS AND DISCUSSION

1. Effect of silicon supplementation on growth parameters

Shoot length –

All plants either weekly or biweekly treated with 100mg/L silicon showed higher shoot length compared to controlled plants. Plants treated with silicon biweekly showed the highest value compared to plants treated weekly with silicon or non treated control. Lowest shoot length was observed in non treated control plants. A significant increase in stem height of plants treated with silicon was observed compared with the control plants. However, there was no significant difference between the stem height of plants sprayed with silicon at weekly intervals and two weeks intervals.

Leaf length and number of leaves-

Plants treated with silicon either weekly or biweekly showed higher leaf length and number of leaves. The highest was observed in plants treated with silicon at weekly intervals. However, no significant difference in the values of leaf length and number of leaves was observed in treated plants compared with the controlled plants. Silicon treatment given at weekly intervals had more impact on increasing the leaf length and number of leaves of *Dendrobium* Orchids. It has been recorded by Vendrame, *et al* in 2010, that the application of KSiO_3 affect overall growth of *Phalaneopsis* orchid liners and increased fresh weight and dry weight of root shoot and whole plant over the controlled plants.

Effect of Silicon supplementation on floricultural quality traits

The lowest time was taken for initiation of buds (24 months) and flowers (25 months) in orchid plants treated with silicon at 100mg/L weekly intervals. This was significantly different with the plants treated with silicon biweekly intervals and non treated plants with Silicon (Table 01).

There were significantly higher number of flowers (14) in a spike in plants treated with silicon at weekly intervals compared to plants provided with silicon at bi-weekly intervals (flowers in a spike -11) and in non treated controlled plants. The highest length and diameter of flowers (9 cm, 7.4 cm) was observed in the plants provided with silicon at weekly intervals compared to the plants received silicon biweekly (diameter of flowers-8.2 cm, 6.2 cm) or in non treated controls (diameter of flowers-8.5 cm, 6.0 cm).

Similarly, the orchid plants provided with silicon at weekly intervals have shown significantly higher length of the spikes (63.20 cm) and diameter (3.07 cm) compared to the plants provided with silicon biweekly (spike length-58.70cm :diameter-1.97cm) or non treated with silicon (spike length-59.16cm :diameter-1.96cm). It can be concluded that Silicon treatment given at weekly intervals had significantly improved the floricultural quality (early bud and flower initiation, increasing the number of flowers in a spike, diameter, length of flowers, spike thickness and length) of *Dendrobium* flowers compared to the plants treated biweekly with silicon (100mg/L) or non treated control plants.

Similar observations have been recorded in sunflower and Zinnias. The diameter of sunflower was significantly increased and flowers had thick straight stems, and increased plant height when silicon was applied as sodium or potassium silicate to the plants as root drenches or foliar spray.

The basal stem diameter of ‘Zinnias’ was also increased when Potassium silicate was applied as a weekly drench at 100mg/L (Kamenidou *et al.*, 2008, 2009).

Savvas *et al* in 2002 also reported that crop quality of Gerbera was increased by having thick stems and quality flowers. Similarly, Kamenidou *et al.*, in 2010 also recorded that Gerbera produced thicker flower peduncles, increased flower diameter, increased height and flowered earlier when treated with sodium silicate. The silicon treated roses also possessed thick stems when treated with silicon (Ehret *et al.*, 2005). All these findings are in agreement with the present study on effects of silicon on improving the floricultural quality traits of *Dendrobium* orchids. Preharvest disease caused by *Pseudocercospora* sp was reduced by over 60% in *Dendrobium* plants treated with 100mg/L weekly intervals than the plants treated with 100mg/L Silicon at bi-weekly intervals or non treated control plants.

Table 01. Effects of silicon supplementation on floricultural quality traits

Treatments	Months for anthesis	Months for Flower initiation	No of flowers	Flower Length (cm)	Flower diameter (cm)	Spikelength (cm)	Spike thickness (cm)
silicon (100mg/L) weekly	24 ^a	25 ^a	14.40 ^a	9.00 ^a	7.40 ^a	63.10 ^a	3.07 ^a
Silicon biweekly	25 ^b	26 ^b	11.20 ^b	8.20 ^b	6.20 ^b	58.70 ^b	1.97 ^b
Control	25.6 ^b	26.6 ^b	11.00 ^b	8.5 ^b	6.00 ^b	59.16 ^b	1.96 ^b

Letters denoted by supercripts indicate significant difference at $P \leq 0.05$ from the Duncan Multiple Range Test.

Levels of silicon in silicon treated plants

The amount of silicon absorbed by the leaves and stems was analyzed in plants treated with different levels of sodium silicate and untreated controls, using spectrophotometry. However, there was no any increase of silicon levels of root or shoot or leaves observed in silicon treated plants compared to controlled plants. The analysis of silicon of plant material was done to quantify presence of molybdate reactive silica (SiO_2), and this form of silica may not be the silicon present in the treated plant. Therefore, results obtained from this experiment had no correlation with the silicon treated and control plant.

2. Effect of silicon supplementation on orchids cultivated in Aeroponics system

Dendrobium cv. *Sonia* grown in the aeroponics system treated with silicon either 50mg/L or 100mg/L were shorter than the control. The lowest height was observed in the plants treated with Silicon (50 mg/L). Silicon treated plants grown in the aeroponics system showed an average higher number of flowers per spike, greater spike thickness and longer spike length compared to untreated control and plants treated with 100mg/L silicon levels.

CONCLUSIONS AND RECOMMENDATIONS

All 100mg/L silicon treated plants either weekly or biweekly showed higher shoot length, higher leaf length and number of leaves compared to controls. Silicon treatment given at weekly intervals had significantly improved the floricultural quality of *Dendrobium* flowers compared to the plants treated biweekly with silicon (100mg/L) or non treated control plants. Plants grown in aeroponics system and treated with 50mg/L silicon weekly showed higher floricultural quality traits.

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CHARACTERIZATION OF POSTHARVEST HANDLING CHAINS OF CUT ORNAMENTALS AT EXPORTER SITES: A CASE STUDY FROM THE WESTERN AND NORTH WESTERN PROVINCES OF SRI LANKA

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INTRODUCTION

The export-oriented floriculture industry in Sri Lanka earns foreign exchange and generates employment. Sri Lanka earned US\$ 14.8 million worth of foreign exchange by exporting floricultural products in 2011, which is a 9% growth over the year 2010 figure (Anon, 2011). However, Sri Lanka's share in the world market is 0.1% (Anon, 2011). The country's diverse agro-climatic conditions can accommodate a range of tropical, subtropical and temperate species of ornamentals (Niranjan and Gunasena, 2011). However, the failure to meet expected quality standards in cut ornamentals is an obstacle in expanding this profitable industry (Anon, 2012). Insufficient quality management or improper actions at different stages of handling cause a loss of quality of the products. Compared to pot plants and rooted stems, cut flowers and foliage are more vulnerable to postharvest quality deterioration. Handling practices adopted from harvesting onwards can have a significant impact on the end-user life of cut ornamentals (Van Doorn and Tijsskens, 1991). Therefore, this study was conducted with a view to understanding the handling chains involved in the export of cut ornamentals and the associated postharvest problems along the chain. The objective was to recognize areas for quality improvement in order to enhance the postharvest performance of cut ornamentals exported from Sri Lanka.

METHODOLOGY

The Western and North Western Provinces, due to their favourable logistics, have become the major location for export floriculture firms. A sample of 33 exporters registered under the Sri Lanka Export Development Board (SLEDB) and whose production nurseries have been located in the Western or North Western Provinces, were therefore, selected for the survey which was conducted from January – May 2013. Data were collected using a structured, pre-tested questionnaire and face-to-face interviews. The information collected included, but was not limited to main products and their origin, quality of supplies, pre-treatments, postharvest handling practices, species-specific postharvest problems, financial and marketing aspects, sanitation and consumer satisfaction. Data were analyzed using STATA (StataCorp, USA) program.

RESULTS AND DISCUSSION

The results revealed that, out of the total range of products, 60% of cut decorative leaves, 32% of unrooted cut stems with leaves and 8% of rooted stems of products were exported to the international market. Cut flowers were rarely exported by the companies in the sample because the products failed to meet international quality standards and also because of the high cost of production involved. Out of the total production 89% was exported to the international market while only 11% was sold in the domestic market. The majority of the respondents (14%) exported *Epipremnum* spp. and *Dracaena sanderiana* followed by *Miscanthus* spp. (13%) and *Cordyline* spp (12%) (Figure 1).

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Exporters had different systems of obtaining products. Eighty one percent of exporters obtained products from outside growers. However, exporters revealed that the products from outside growers rarely matched the required quality standards. Among the outside growers, 83% cultivated plants in open fields without providing artificial shade in the form of net houses or poly tunnels. Only 16% of growers grew plants under shade nets.

A majority of the outside growers (92%) used soil while 8% of them used a potting medium with coir dust and compost added to the soil. Approximately 78% of the exporters obtained products from their own nurseries. 82% percent of exporters stated that the products obtained from owned nurseries were 'excellent in quality' while 18% mentioned that they were 'good in quality'.

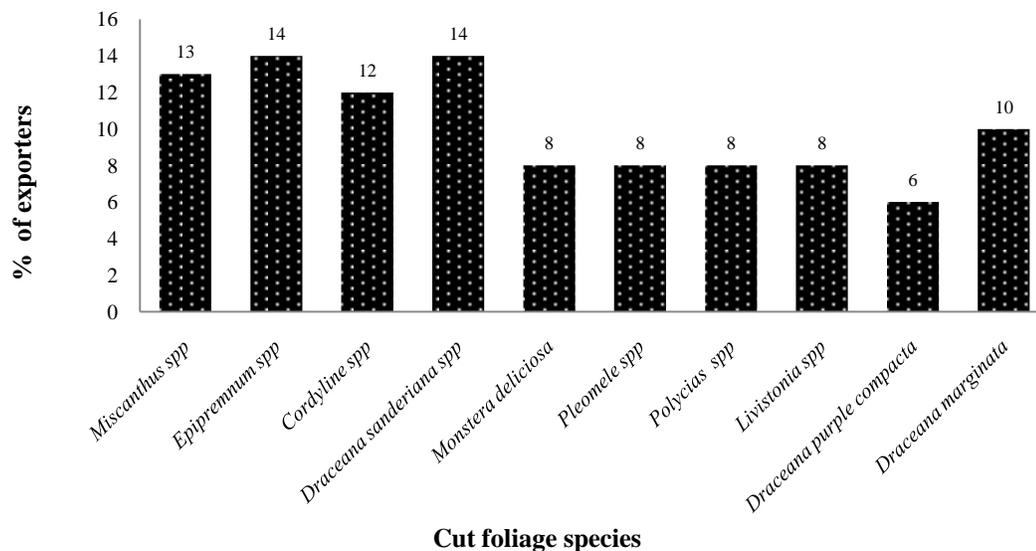


Figure 1. Major species of cut foliage exported.

Harvested cut foliage and stems were delivered to the export companies by the outside growers without subjecting them to any special postharvest treatment with preservatives. About 98% of outside growers delivered their harvest by public transport (e.g. by bus) or by private transport systems such as motor-bikes and small trucks without maintaining the cold chain. Only 2% of growers used refrigerated transport systems particularly for *Codiaeum* spp., *Aglaonema* spp., *Calathea* spp. and *Philodendron* spp. A majority of the outside growers (81%) did not use proper packaging to deliver the harvest to the exporters. They packed cut foliage as tight bundles. Only 19% of outside growers used a proper packaging system consisting of plastic containers. Products below the export quality standard have been rejected at exporter sites (Table 1). About 33% of exporters had rejected 20% of outside supplies per month (Table 1). Major reasons for rejection were: products not in the right stage, improper colour, wilting, pest and disease problems and mechanical damages during transport. Non-uniformity of the growing environment, sub-optimal light levels and crop management practices could have resulted in improper colour of foliage products and pest and disease problems. Inappropriate packaging leads to mechanical damages while dry and non-refrigerated transport systems result in wilting problems due to water loss coupled with product energy depletion.

Cut foliage should be harvested during a cool part of the day so that their metabolic rate is low and removal of field heat is less difficult. However, in most of the nurseries (93%), harvesting was not done at specified times of the day. Cut stems were trimmed, graded and sorted according to customers' requirements, to eliminate diseases incidence, physical damages and insect attacks.

Seventy nine percent of exporters did not use any pre-treatments to extend postharvest life. Only 21% exporters used treatments solely to control pests and diseases. Sixty seven percent of exporters used pre-cooling systems, which consisted of walk-in cold rooms, before dispatch. There were incidents of damage due to over cooling during cold storage. Yellow patches, wilting, and blackening of leaf margins were the most common symptoms. However, 33% of exporters did not practice pre-cooling as their nurseries and packing houses were in close proximity to the airport. Nonetheless, pre-cooling is an essential practice to extend the longevity of fresh horticultural produce. It is important to identify the best range and duration of cool storage for different species to avoid low temperature injury.

Table 1. Frequency of rejecting the supplies provided by outside growers at the exporter sites.

Rejections/Month (%)	Exporters (%)
< 5	26
5	9
10	8
15	8
20	33
30	13
35	3

The majority of the exporters (77%) used dry packing system and 22% of exporters used wet packing, *i.e.* wet cotton wool soaked in water is kept at cut stem-end. All exporters used corrugated cardboard boxes as the primary package. Seventy three percent exporters delivered their products to the airport using normal temperature transport systems while only 27% used refrigerated trucks. Frequent rejections and complaints have been received from foreign buyers. Major complaints were revealed to be over-cooling or heating damages, low quality packaging materials, long internal transport, and damages during transport, wilting problems and low quality products. Wilting problems at the end-user could be caused by poor water status of the cut stems.

CONCLUSIONS/RECOMMENDATIONS

The sub-standard quality of supplies from outside growers, inappropriate packaging and transport methods, failure to maintain cold chain throughout, damages caused by extensive security checks at various points have caused quality loss of produce. Moreover, non-adoption of postharvest treatments to improve water status of cut stems and foliage could have a negative impact on their end-user shelf life. Postharvest pulse treatments with surfactants (wetting agents) and preservatives, applied before dispatch can improve the water status of cut stems. The quality of products degrades due to inappropriate handling practices by the workers. Frequent supervision and providing necessary skills to the workers would minimize that problem. The results of this study indicate areas for quality improvement in handling chains at exporter sites. Further research will estimate the end-user life of a range of cut ornamental products after simulated export.

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ISOLATION OF ANTIBIOTIC PRODUCING BACTERIA FROM SOIL AND DEMONSTRATING THEIR PATTERN OF ANTIBIOTIC PRODUCTION DURING BATCH CULTURE

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INTRODUCTION

Competition, which is a negative interaction among microorganisms, arises when different microorganisms within a population or community try to acquire the same resource, whether this is a physical location or a particular limiting nutrient. 'Amensalism' is the unidirectional process based on the release of a specific compound by one organism which has a negative effect on another organism during competition. A classic example of amensalism is the production of antibiotics that can inhibit or kill a susceptible microorganism (Prescott, 2002). Antibiotics are classes of chemical compounds which are derived mainly from microorganisms (Van Epps, 2006). Based on the chemical structure of naturally produced antibiotics, similar substances are produced wholly or partly by chemical synthesis; which in low concentrations inhibit the growth of one or more other species of microorganisms (Kelmani, 1997). Soils and habitats lacking organic matter stimulate microorganisms to produce antibiotics to eliminate competitors (Waksman and Woodruff, 1940). During the current study, antibiotic producing bacteria were isolated from different soil environments. Primary screening was done using the spot test and the cross streaking method. Agar well diffusion technique was used for secondary screening to confirm the results from the primary screening. Identification of antibiotic producing bacteria and characterizing them up to the species level was performed using several morphological and biochemical tests. The growth curves of the isolates were constructed to study the relationship between the growth phase and antibiotic production. The underlying principle of antibiotic production as a result of depletion in nutrients or space when bacterial growth reaches the stationary phase was studied.

METHODOLOGY

Screening for antibiotic producing isolates

Samples from different soil environments were tested for the presence of antibiotic producing bacteria by screening soil bacterial isolates for antibiotic production using standard cultures (*Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Bacillus subtilis*). A dilution series was prepared using soil and each dilution was plated out using nutrient agar. After incubation, well isolated bacterial colonies were used for the spot test where they were spotted on a lawn of standard organisms spread on an agar surface using the spread plate technique. The cross streak method was also performed for primary screening where a perpendicular streak was performed using the isolate across a streak made using the standard culture. The agar well diffusion method was used for secondary screening. A solution of antibiotic containing cell free suspension was obtained by growing the isolate in nutrient broth and filtration using the Hemming's filtration technique. The antibiotic solution was poured into metal wells placed on an agar surface spread with a standard culture. The primary and secondary screenings were done in triplicate for accuracy. Antibiotic producing *Bacillus subtilis* was used as the positive control while a culture of *Escherichia coli*, which is a non-antibiotic producer, was used as the negative control during primary and secondary screening.

Identification of the isolates

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Morphological studies and biochemical tests were performed to identify the antibiotic producing isolates into their genus and species levels. (Motility of the isolates, Grams' stain of the isolates, Endospore staining, Catalase test, Oxidase test, Glucose fermentation test, Oxidative/fermentative test (Hugh and Leifson's' test), Test for anaerobic growth, Test for acid production from carbohydrates, Hydrolysis of casein and gelatin, Hydrolysis of starch, Utilization of citrate, Nitrate reduction test, Indole test, Urease test, Temperature tests, Growth in *Pseudomonas* selective media, Florescence test, Growth on MacConkey Agar, Arginine dihydrolase, Pigment production and Egg yolk reaction)

Construction of the growth curve

A small amount of inoculum from a selected isolate was transferred to 10 ml of sterilized nutrient broth in a test tube. It was incubated for 24 hours. Nutrient broth (90 mL) was prepared in a 500 mL screw capped flask and was autoclaved. Incubated 10 mL broth was aseptically transferred to the 500 mL screw capped flask containing 90 mL of nutrient broth and the added time was recorded as zero. It was shaken well and a dilution series was prepared up to 10^{-8} using 1 mL of the original sample. Each dilution (1 mL) was plated out using nutrient agar. The flask was continuously shaken at a constant rate of 250 r.p.m. At constant time periods i.e. every 30 minutes for 14 hours, 1 mL of the original broth was pipetted out and using a dilution series, pour plating was performed. The plates were incubated for 24 hours in an inverted position using the 30 °C incubator. The number of colony forming units were counted and recorded.

Determination of antibacterial activity

An overnight broth culture of a particular test organism was inoculated on to the surface of a solidified Mueller Hinton agar plate using the spread plate technique. Stainless steel autoclaved antibiotic wells (6 mm in diameter) were placed on Mueller Hinton Agar. A Cell free suspension of the antibiotic producing isolate was obtained using Hemming's filtration. Using a micropipette, 200 µL of the cell free suspension was aseptically and carefully added into the well. The plates were incubated at a face-up position for 24 hours in a 30 °C incubator.

Statistical analysis of data

Data was analyzed using the MINITAB 14 software package. Correlation between the diameter of the inhibition zone and the Log CFU/mL was tested with Pearson correlation analysis. A linear regression analysis was performed to determine the relationship between the log CFU/ml and time (min), during the log phase of the growth curves.

RESULTS AND DISCUSSION

A zone of inhibition was observed around isolates spotted on a bacterial lawn grown on nutrient agar during primary screening. The diameters of the zones of inhibition vary with the type of isolate and the type of bacterial lawn. The observation of a clear zone was recorded. (Table 1) When the tested organism is streaked over by the isolate, growth suppression in the region streaked, indicates a positive result. The growth of each isolate against the tested organisms is indicated in Table 1.

Table 1: Results of primary screening for antibiotic production (Spot test and Cross streak method) and secondary screening (Agar well diffusion method).

Isolate	Formation of a clear zone and the mean diameter of the clear zones (mm)			
	<i>B.subtilis</i>	<i>E.coli</i>	<i>P. aeruginosa</i>	<i>S.aureus</i>
MS ₂ 4	-	-	-	+ (15mm)
KD1	+ (19 mm)	-	-	+ (23mm)
KD6	+ (21 mm)	-	-	+ (24mm)
Positive Control <i>B. subtilis</i>	-	+(19mm)	+(18mm)	-
Negative Control <i>E. coli</i>	-	-	-	-

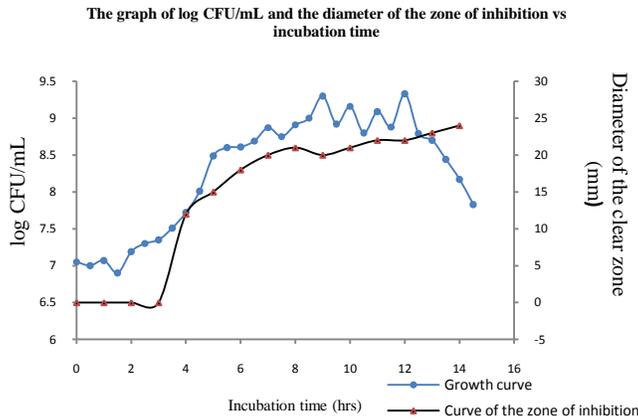
+ (Positive result)

- (Negative result)

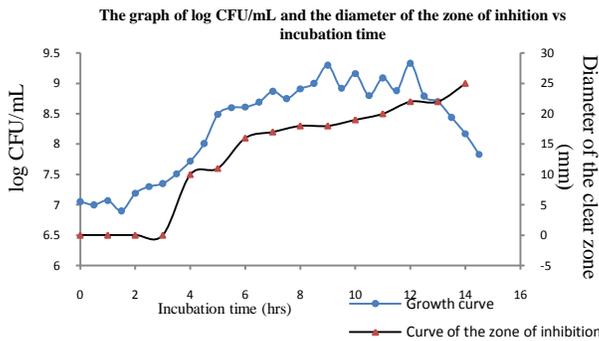
According to the results of the microscopic characteristics and the biochemical tests, the isolates were identified using the 'first stage table for Gram negative bacteria' in the Cowan and Steels' manual (Cowan, 1989), the 'second stage table for identifying Pseudomonads' in the Cowan and Steels' manual and using the Bergy's Manual of Systematic Bacteriology. MS₂4 isolate was identified as *Pseudomonas putida* and both KD1 and KD6 isolates were identified as *Pseudomonas aeruginosa*.

Physical parameters such as temperature, design of the shaker flask, shaking speed, volume of the broth, agitation and aeration plays a key role. Therefore during the design of the laboratory shaker flask incubator setup, a presumed set of physical parameters for the incubation of Pseudomonads were employed and the same parameters were continuously followed during repeated incubation processes.

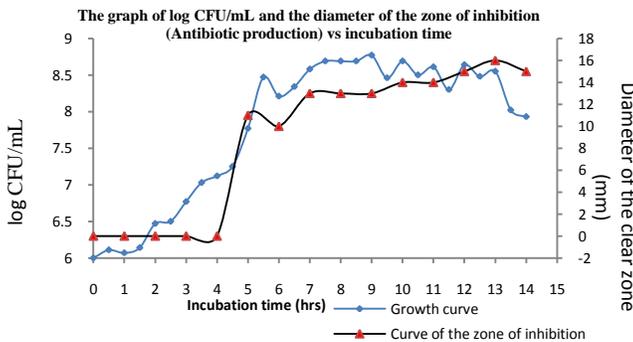
According to graph 1 and graph 2, cultures KD1 and KD6 took six hours to reach the stationary phase. The stationary phase persists for around 6hours till the death phase. The time taken for the isolate MS₂4 to reach each phase of growth was quite similar to that of KD1 and KD6.



Graph 1: Growth curve of KD1 and the zone of inhibition against *Staphylococcus aureus*



Graph 2: Growth curve of KD1 and the zone of inhibition against *Bacillus subtilis*



Graph 3: Growth curve of MS₂₄ and the zone of inhibition against *Staphylococcus aureus*

Bacteria in the lawn and an isolate spotted on it will compete for nutrients and space in the nutrient agar plate. This will lead to the production of inhibitory substances that would inhibit the competitor (Atlas, 1995).

Primary and secondary screening revealed that the growth of Gram negative *Pseudomonas aeruginosa* has the ability to inhibit the growth of Gram positive *Staphylococcus aureus* and *Bacillus subtilis*. Gram negative *Pseudomonas putida* can inhibit the growth of *Staphylococcus aureus* but not *Bacillus subtilis*. This might be due to the antibiotic produced by *Pseudomonas putida* being specific only for the inhibition of *Staphylococcus aureus* or as the concentration of the antibiotic is deficient than the minimum inhibitory concentration needed to inhibit *Bacillus subtilis*.

Growth curves were constructed for all three isolates. The basic focus during the construction of the growth curve was on the time taken for the culture to reach the stationary phase which is important for the antibiotic production. The growth was measured in terms of colony forming units per milliliter (CFU/mL). The production of antibiotics is believed to take place in the late logarithmic phase or in the stationary phase. (Atlas, 1995)

production increased with time during the stationary phase. The amount of antibiotic produced did not decrease with the death phase of growth due to the accumulation of it in the broth.

Statistical analysis of data explains that there is a correlation between log CFU/mL and the diameter of the zone of inhibition for all three isolates ($R\text{-Sq} = 82.3\%$, $P < 0.05$). However, based on the assumption that the diameter of the clear zone is directly proportional to the amount of inhibitory compound/antibiotic produced, it can be stated that there is a correlation between the growth of bacteria and antibiotic production.

CONCLUSIONS/ RECOMMENDATIONS

During the screening process, one of the notable features found was that some isolates, those that displayed strong antagonism against many other bacteria of the same habitat failed to show such strong activity against test organisms. This may be because they have evolved to gain the capacity to fight against competitors in their own habitat, but not against the limited number of laboratory strains chosen by us. Among the isolates, those belong to the Genus *Pseudomonas* were found to have the strongest antagonistic activity against test organisms. The degree of growth inhibition was found to be dependent on the isolate, test organisms, phase of the growth and changing environmental/ growth parameters. The growth curves constructed using the results of the particular isolates (MS₂₄, KD1 and KD6) confirmed the established principle which says that the antibiotics are usually produced starting from the end of the log phase and during the stationary phase of growth.

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RELATIVE IMPORTANCE OF MYSIDS AS A FOOD ITEM IN THE DIET OF TWO SMALL FISH SPECIES, *Galaxias maculatus* and *Athrinidae* sp. IN THE KAKAMATUA STREAM, AUCKLAND REGION, NEW ZEALAND

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INTRODUCTION

Mysids occupy a wide variety of aquatic environments and can be a significant biological component both numerically and in terms of biomass in these ecosystems. They are important in the consumption of suspended matter in the detritus-based estuarine food webs (Fockedy & Mees, 1999). Mysids are an important food source for ecologically and commercially important fish. Thereby, they become an important link in estuarine food chains, and play a critical role in the cycling of energy within the system.

Mysids have been reported to be an important component of the diet of many juvenile fish such as young yellow-eyed mullet *Aldrichetta forsteri* and common bully *Gobiomorphus baslia* in the Avon-Heathcote Estuary New Zealand, the European perch *Perca fluviatilis*, in the Selwyn River, Canterbury, particularly during summer and yearling salmon *Oncorhynchus tshawytscha*, in bays along Akaroa Harbour in New Zealand. In order to determine the ecological importance of mysids, this study focuses on its relative importance as food item using stable isotopic study and the gut content analysis of fish.

More traditional method of gut content analysis has several drawbacks. It reflects immediate feeding pattern only. Sometime it hinders identification, notably due to quick digestion of prey. Therefore, Stable Isotope Analysis (SIA) can provide a measure of feeding relationships of an organism, by visualizing all the possible trophic pathways leading to the organism (Peterson & Fry, 1987). This analysis is an effective tool integrating long-term assimilation of nutrients, and it may not reflect short term feeding patterns (Johannsson *et al.*, 2001). In such cases, SIA can provide a useful alternative tool and give insights into the feeding relationships between the organisms within a given food web (Post, 2002).

METHODOLOGY

Fish species *Galaxias maculatus* Jenyns, 1842 and *Athrinidae* sp. were collected from Kakamatua stream situated on the west coast of Auckland region. *Galaxias maculatus* (whitebait) was very common and *Athrinidae* sp. was rarely found at this site where the mysid species *Tenagomysis chiltoni* Tattersal, 1923 and *Tenagomysis novaezealandiae* Thomson, 1900 are highly dominated. These samples were collected for gut analysis in late January 2009 (summer) and the specimens were fixed in 5% formalin immediately.

Ten specimens from each fish species were dissected out and the stomach contents were mixed in a beaker with 10 ml water. After mixing the contents properly 1 ml of the sample was drawn and spread on a Sedgwick rafter. The gut content was examined under the microscope fitted with an eye piece micrometer. At each trial twenty squares were observed and there were three trials totaling to sixty squares per specimen. The number, volume and the frequency occurrence of different types of food materials were recorded. Percentage occurrence (F%), percentage volume (V%) percentage numbers (N%) and index of relative importance (IRI) were calculated as given by Hyslop (1980).

$$\text{Percentage occurrence (F\%)} = \frac{\text{The number of stomachs in which a given food item is found}}{\text{Number of stomachs examined}} \times 100$$

$$\text{Percentage numbers (N\%)} = \frac{\text{The number of stomachs in which a given food item is found}}{\text{Number of total food items in all specimens}} \times 100$$

$$\text{Percentage volume (V\%)} = \frac{\text{Volume of one food item found in all specimens}}{\text{The volume of all food items in all specimens}} \times 100$$

$$\text{Index of Relative Importance (IRI)} = F\% \times (N\% + V\%)$$

To study the feeding relationships using SIA, samples of fish species and mysid species were collected from the stream, Kakamatua, sealed in plastic bags, and stored in a freezer (-20°C) until processing. All the samples were oven-dried to constant weights at 40°C , then ground to obtain a homogeneous powder. Three replicates of each sample were prepared. The whole body of the mysid samples was considered. For the fish samples, only the muscle was used for the analysis. All animal samples of approximately 20 mg were processed by the Waikato Stable Isotope Unit, The University of Waikato, Hamilton, New Zealand. The carbon value ($\delta^{13}\text{C}$) was measured to a precision of $\pm 0.1\%$ and samples were referenced to a precalibrated C_4 sucrose standard that was cross-referenced to the Pee Dee belemnite standard (Craig, 1957). The nitrogen value $\delta^{15}\text{N}$ was measured to a precision of $\pm 3\%$, and samples were referenced to an urea standard which was traceable to atmospheric nitrogen (Mariotti, 1983). The ratios of $^{13}\text{C}/^{12}\text{C}$ and $^{15}\text{N}/^{14}\text{N}$ are expressed as relative difference using the following equation.

$$\delta^{13}\text{C} = \left\{ \left(\frac{^{13}\text{C}/^{12}\text{C sample}}{^{13}\text{C}/^{12}\text{C standard}} \right) - 1 \right\} \times 10^3 \text{ and}$$

$$\delta^{15}\text{N} = \left\{ \left(\frac{^{15}\text{N}/^{14}\text{N sample}}{^{15}\text{N}/^{14}\text{N standard}} \right) - 1 \right\} \times 10^3$$

The stable isotope values of $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ were used to visualize the trophic position of each collected food links of the Kakamatua Stream ecosystem.

RESULTS AND DISCUSSION

The gut content of *Athrinidae* sp. showed that they have fed on eight different food items. Among the *Athrinidae* sp. eight fish fed on diatoms, eight fed on rotifers and seven fed on filamentous algae. The other food items found in the guts were Ostracods, bivalves, copepods, Cladocerans and plant detritus (Table 1). The gut analysis of *Athrinidae* sp. revealed that the values of N% and V% are highest, for filamentous algae. The IRI value is highest in diatoms. Filamentous algae, diatoms and rotifers were the three most important food items respectively (Table 1 and Fig. 1).

The gut content of *G. maculatus* indicated that they fed on 12 different food items. Among the 10 individuals analyzed six fed on mysids, five fed on cladocerans and four fed on amphipods. The other food items were ostracods, gastropods, bivalves, dipterans, coleopterans, rotifers, filamentous algae, diatoms and sand particles. The gut content analysis of *G. maculatus* showed that F%, N%, V% and IRI values were highest in mysids and the second highest in amphipods (Table 2, Fig. 2).

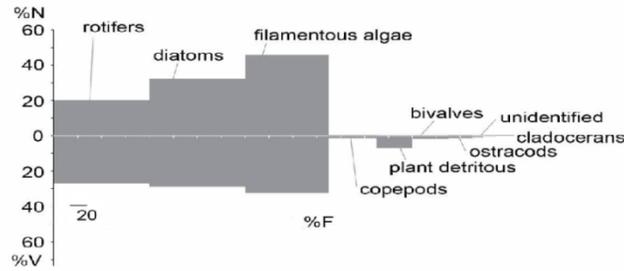


Figure 1: Diet of *Athrinidae* sp. from the Kakamatua stream expressed as percentage index of relative importance area chart ($n=10$), where %N is the percentage contribution by number, F% by occurrence and %V by volume

Table 1: Gut content analysis of *Athrinidae* sp. accordance with F%, N%, V% and IRI.

Food type	F%	N%	V%	IRI
Diatom	80	32.09	29.22	2369.69
Filamentous algae	70	45.01	32.88	2346.29
Rotifers	80	21.39	25.68	2075.87
Plant detritus	30	0.45	6.73	202.31
Bivalve	30	0.13	2.21	66.49
Copepod	40	0.40	1.61	64.66
Ostracods	20	0.36	1.37	27.83
Cladocerans	10	0.09	0.26	2.65
Unidentified	10	0.09	0.05	0.55

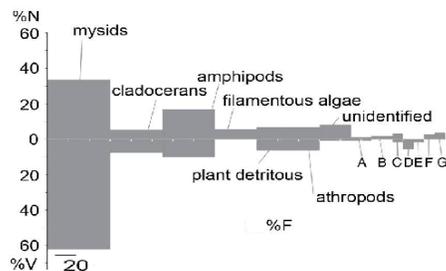


Figure 2: Diet of *G. maculates* from the Kakamatua stream expressed as percentage index of relative importance area chart ($n=10$), where %N is the percentage contribution by number, F% by occurrence and %V by volume. Legend: A, ostracods; B, rotifers; C, gastropods; D, diatoms, E, coleopterans F, diatoms, G, sand particles.

Table 2: Gut content analysis of *G. maculatus* accordance with F%, N%, V% and IRI.

Food type	F%	N%	V%	IRI
Mysids	60	33.74	61.94	5740.7
Amphipods	50	17.07	9.83	1345.4
Cladocerans	50	5.28	7.30	629.2
Plant detritus	30	6.77	5.80	377.3
Unidentified animal parts	30	11.38	0.82	366.2
Unidentified matter	30	7.72	1.22	268.4
Filamentous algae	40	5.28	0.31	223.8
Dipterans	10	0.41	5.99	63.9
Gastropods	10	1.63	3.54	51.7
Rotifers	20	2.03	0.27	46.1
Ostracods	20	1.63	0.55	43.5
Sand particles	10	3.25	0.34	35.9
Diatom	10	3.25	0.09	33.4
Coleopterans	10	0.41	1.99	23.9

Stable Isotopic $\delta^{13}\text{C}$ values showed that *Athrinidaes* had the highest $\delta^{13}\text{C}$ values (-19.5 to -19.43 ‰) and juvenile *T.chiltoni* had the lowest $\delta^{13}\text{C}$ values (-23.09 to -23.2 ‰) than others respectively. The $\delta^{13}\text{C}$ values of:juvenile *G. maculatus* -22.49 to -21.66 ‰; *G. maculatus* -20.76 to -19.92 ‰; *T.novaezealandiae* -20.06 to -19.58 ‰ and adult *T. chiltoni* -21.48 to -20.49 ‰(Fig. 3).

The $\delta^{15}\text{N}$ value of increasing order:*Athrinidae* sp. 10.92 to 11.09 ‰;*T. novaezealandiae* 10.9 to 12.3 ‰; ‰juvenile *T. chiltoni* 11.38 to 11.49 ‰; adult *T. chiltoni* 10.61 to 12.5 ‰; juvenile *G. maculatus*had 11.77 to 12.86 ‰; *G. maculatus* 12.9 to 13.6 ‰ (Fig. 3).

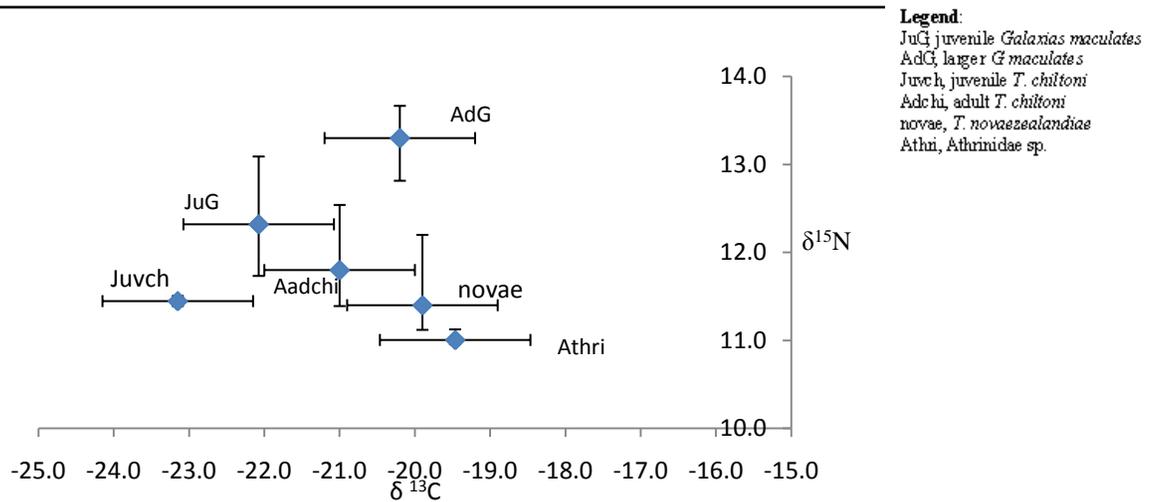


Figure 3: Mean (\pm SD) ($n = 3$) carbon and nitrogen stable isotopic composition of samples collected from Kakamatua Stream ecosystem.

Depending on the hypothesis of differences in $\delta^{15}\text{N}$ value between the consumers and the diet, a consumer is typically enriched by 3–4 ‰ relative to its diet (DeNiro & Epstein, 1981; Minagawa & Wada, 1984; Peterson & Fry, 1987), and depending on the above argument, the $\delta^{13}\text{C}$ value of the consumer is enriched up to 1 ‰ and it may be large as 3 ‰ relative to the food sources (DeNiro & Epstein, 1978), following conclusions were given by visual inspection (Fig. 3). Based on the SIA result (Fig. 3), it is evident that $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values of *T. chiltoni* ($\delta^{15}\text{N}$: 10.61–12.5‰; $\delta^{13}\text{C}$: -23.09 to -23.2 ‰) and *T. novaezealandiae* ($\delta^{15}\text{N}$: 10.9–12.3‰; $\delta^{13}\text{C}$: -20.06 to -19.58‰), are closely linked with adult *G. maculatus* ($\delta^{15}\text{N}$: 12.9–13.6‰; $\delta^{13}\text{C}$: -20.76 to -19.92‰) while juvenile *G. maculatus* ($\delta^{15}\text{N}$: 11.77–12.86‰; $\delta^{13}\text{C}$: -22.49 to -21.66‰) link with juvenile *T. chiltoni* ($\delta^{15}\text{N}$: 11.38–11.49 ‰; $\delta^{13}\text{C}$: -23.09 to -23.2 ‰). However, *Athrinidae* sp. ($\delta^{15}\text{N}$: 10.92–11.09‰; $\delta^{13}\text{C}$: -19.5 to -19.43 ‰) do not link with any mysid species collected from the ecosystem. It is apparent that juvenile *G. maculatus* feed on juvenile *T. chiltoni* where as adult *G. maculatus* feed on the adult *T. chiltoni*. This agrees with the Redon et al. (1994) that the juvenile spotted flounder contained a greater number of mysids in their stomachs whereas in the larger fish, decapods and fishes were the more abundant food items.

The gut content analysis of the present study revealed that *G. maculatus* fed on 11 different food items and based on IRI value mysids were the principal food item, secondly amphipods and thirdly cladocerans. This suggests that *G. maculatus* prefers mysids but they act as opportunistic feeders. The gut content analysis of *Athrinidae* sp. suggests that they feed on eight different food items but mysids were not among them. Thus the stable isotopic values and the gut content analysis of fish have shown the same results that *G. maculatus* fed on mysids whereas *Athrinidae* sp. did not.

The novel part of this study is the analysis of food materials using SIA which indicates resource partitioning among juvenile and adults a strategy of coexistence.

CONCLUSIONS

It is evident from both methods that *T. chiltoni* and *T. novaezealandiae* form a substantial component of the diet of commercially important *G. maculatus*, at Kakamatua stream. Changes in the diet, during the ontogenetic development, in relation to body size have shown a significant enrichment of $\delta^{15}\text{N}$ values and $\delta^{13}\text{C}$ values of *T. chiltoni* and *G. maculatus*.

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MORPHOMETRIC CHARACTERISATION OF THE GENUS *Mycalesis* BUTTERFLIES IN SRI LANKA

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INTRODUCTION

Butterflies of the subtribe Mycalesina (family Nymphalidae, subfamily Satyrinae) are restricted to Africa, Indo-Australia and certain parts of temperate Asia (Kodandaramaiah *et al.*, 2010). The genus *Mycalesis* consisting of over 100 species is spread throughout the Australasian region (Kodandaramaiah *et al.*, 2010). The five species found in Sri Lanka are *M. rama*, *M. subdita*, *M. perseus*, *M. mineus*, and *M. patnia* of which the former two are endemic with *M. rama* categorized as endangered (Van der Poorten, 2012). Members of this subtribe inhabit forest edges, grasslands and savannahs preferring the early morning or late evening low light conditions to venture out into the open. As non-migratory species, these butterflies display polyphenism as a mechanism to survive the wet and dry seasonal changes in their habitats (Braby, 1994). In some species, polyphenism is accompanied with behavioral, reproductive and habitat changes. In Sri Lanka polyphenism has resulted in dry and wet seasonal forms as well as geographically variable morphological forms in the different climatic zones of the country (Ormiston, 1924). This makes identification of *Mycalesis* species somewhat difficult.

As the genus has diverse phenotypes that vary geographically and seasonally within species, this group shows strong potential for research that investigates scientific issues such as the general processes driving adaptation and evolution and impacts of climate change. In Sri Lanka, studies on seasonal polymorphism in butterflies have not received much attention. Though past literature has described the seasonal and geographical variation in morphology of *Mycalesis* species found in Sri Lanka, primarily based on wing coloration, size of dorsal forewing ocelli, width of the discal band and size of ocelli on the ventral surface, the information available appears to be incomplete and inconsistent between authors (Bingham 1905; Talbot, 1947, Woodhouse, 1950). The objectives of this study, therefore, were to carry out a comprehensive morphometric analysis to characterize the *Mycalesis* species present in Sri Lanka and to determine the important morphological parameters that could be used in the identification of seasonal forms. This study was undertaken as part of an overall study which is investigating the evidence for local adaptation, if any, by focusing on the intra- and inter-specific genetic variation of Sri Lankan *Mycalesis* butterflies.

METHODOLOGY

Sampling: Butterflies of the genus *Mycalesis* were sampled from 7 districts representing the three climatic zones in the island during 2012 and 2013. Site selection was based on previous sightings of the *Mycalesis* species. Adult butterfly specimens were captured from each location using nets and baited traps. GPS data were recorded from each location. Specimens were identified with standard taxonomic keys prior to preserving as voucher specimens. Genitalia were dissected and forelegs were cleaned of hair and scales before observation under a stereo microscope.

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Morphometric measurements: 36 morphometric characters were measured for each butterfly to obtain a complete representation of the wing elements, genitalia and forelegs of the *Mycalesis* specimens. Fourteen wing characters were measured using a vernier caliper (0.05mm accuracy). Six genital and five foreleg characters were measured with a calibrated eyepiece micrometer (0.03mm accuracy). The colour of the proximal half of the discal cell in the dorsal forewing was measured from a 5x5 pixel area with ColorPic software (ICONICO). An ordinal scale was created to represent the range of colours. Each wing, genital and foreleg character of the butterfly was represented as an average relative size of the wing length from base to apex, total clasper length of genitalia and the total length of foreleg, respectively.

Of the 36 characters in the matrix, eight were initially selected for the morphometric analysis of variation between and within species. The characters selected for quantitative analysis included the diameter of dorsal forewing ocellus (DFWoc), forewing length from base to apex (BA), width of ventral forewing discal band (VFWwDis), colour of ventral forewing (VFWcol), diameter of ventral forewing 5th ocellus (VHW5oc), length of clasper (Lcl), length of dorsal process of clasper (LDcl) and length of trochanter of foreleg (LTr).

RESULTS

A total of 80 specimens of four *Mycalesis* species (except *M. rama*) collected from the island were analysed for the selected eight parameters as shown in Table 1.

Table 1. Descriptive statistics of wing, genital and foreleg parameters of *Mycalesis* in Sri Lanka.

Parameter	Average relative size (mm) ± SD (range)			
	<i>M. perseus</i>	<i>M. mineus</i>	<i>M. subdita</i>	<i>M. patina</i>
DFWoc	0.03 ± 0.03 (0.00 - 0.08)	0.16±0.03 (0.10-0.21)	0.16±0.02 (0.12-0.19)	0.24±0.02 (0.21-0.27)
BA	19.75±2.25 (13.15 -24.70)	21.84±1.42 (19.20-23.75)	21.43±0.97 (19.75-22.60)	20.20±1.06 (18.05-23.05)
VFWwDis	0.03 ± 0.01 0.01 - 0.06	0.05±0.01 0.03-0.07	0.04±0.01 (0.01-0.05)	0.06±0.01 (0.04-0.08)
VHW5oc	0.10±0.02 (0.04-0.14)	0.12±0.01 (0.08-0.15)	0.10±0.03 (0.05-0.12)	0.07±0.01 (0.05-0.10)
Lcl	0.58 ± 0.10 (0.33-0.72)	0.45±0.18 (0.26-0.75)	0.53±0.10 (0.41-0.65)	0.90±0.01 (0.88-0.93)
LDcl	0.18 ± 0.03 (0.12 - 0.23)	0.07±0.01 (0.04-0.09)	0.12±0.02 (0.10-0.14)	0.10±0.01 (0.07-0.12)
LTr	0.36 ± 0.03 (0.29 - 0.41)	0.40±0.04 (0.37-0.56)	0.39±0.05 (0.33-0.45)	0.38±0.04 (0.31-0.54)

All characters showed considerable individual variation among the specimens. Based on classification and regression tree (CRT) analysis, the highly variable characters between the species were DFWoc (100%), LDcl (70.3%) and Lcl (68.6%). The least variable of the characters were VHW5oc (2.4%) and BA (8%).

Wing characters: Wing length of *M. perseus* (92.86%) and *M. patina* (82.76%) was observed to be smaller (<20.9mm) and *M. mineus* (68.42%) and *M. subdita* (83.33%) were generally larger (>20.9mm). In majority of *M. mineus* (84.21%) and *M. subdita* (83.33%) specimens, the size of

DFWoc was found to vary between 0.054-0.18mm. In comparison, 85.71% of *M. perseus* had a smaller diameter (<0.054mm) and *M. patnia* had the largest ocellus diameter (>0.18mm). There was a gradual variation in VFWcol from very light brown to very dark brown in *M. perseus* individuals. *M. mineus* was also observed to vary from the light to the darkest colour scale. However, a higher proportion of specimens were found to be light brown in shade. The VFWcol of all captured specimens of *M. subdita* was very dark in colour and all *M. patnia* butterflies were yellow brown in colour. Within the genus *M. patnia* was easily distinguished with the presence of an ochreous yellow-orange triangular patch on the dorsal surface of the forewing extending from directly behind the large ocellus at CuA1 to midpoint of the discal cell. The ocellus itself is not symmetrical as in the other *Mycalesis* and consists of a thicker ochreous yellow semicircle.

Genital characters: The relative clasper length of most *M. perseus* (60.71%) was between 0.54 – 0.89mm with the remaining specimens having a length of <0.54mm. A higher proportion of *M. patnia* (82.76%) was shown to possess relatively longer claspers of >0.89 mm. Claspers of *M. patnia* are remarkably different from the other *Mycalesis* consisting of a thin, long clasper with a small rounded dorsal process. The distal process is absent and the ventral surface of the clasper has a row of thick hairs running its length to midpoint. The claspers of *M. perseus* genitalia were broader than in the others, with a well rounded dorsal process. This feature could be used as a distinguishing character for this species. The diameter of the clasper was narrowest in *M. mineus* among the four species.

Foreleg characters: The size of the foreleg was found to vary only slightly between species. However, the longest trochanters (>0.37mm) were possessed by *M. mineus* (84.21%), *M. subdita* (66.67%) and *M. patnia* (58.62%), indicating a general tendency for these three species to have a longer foreleg. *M. perseus* forelegs were among the smallest, with longer and thicker hair than the other three species.

Phenotypic variations in wet and dry season forms: Among the collected specimens there were wet and dry season forms as well as intermediate forms that could not be clearly classified into either a wet or dry category. These seasonal forms were not strictly confined to their respective dry or wet period of the year. Except *M. patnia*, the other three species showed seasonal polyphenism in the size of DFWoc and VFWDis. These changes were most pronounced in *M. perseus*. Wet season forms were generally observed to possess a large prominent ocellus and a thick discal band. Particularly in *M. perseus*, the dorsal forewing ocellus was absent in some wet season forms. The typical dry season forms were observed to differ from the wet season form in having a smaller ocellus and a thinner discal band. In these dry season morphs, the outer rings of the dorsal forewing ocellus tend to disappear with the white center becoming more prominent.

DISCUSSION

The preliminary data collected in this study indicate that *M. mineus* and *M. subdita* exhibit closer similarity in the size of forewing, dorsal forewing ocellus, ventral forewing discal band, clasper and foreleg, with majority of specimens in each species falling to the same size class for the respective character. Such morphological similarity confirms the close association emphasized by Bingham (1905) and Ormiston (1924) between *M. mineus* and *M. subdita* within the genus. Such similarity makes the identification of *M. subdita* and *M. mineus* difficult, compelling researchers to rely on other subjective parameters as the purplish tinge of the proximal edge of the ventral wings or the sharp edges of the DFWoc compared to the faded ones of *M. mineus*.

The patterns of seasonal phenotypic variations in ventral hindwing ocellus size and forewing length observed in this study are similar to those reported for tropical *Mycalesis* species studied from other parts of the world (Braby 1994). The larger size of dry season forms and their dull cryptic colourations that resemble the surrounding dry vegetation are believed to be mechanisms to minimize predation, as this is the period during which the female butterflies remain restive in reproductive diapause (Braby, 1994).

In the specimens examined so far in this study, no consistent seasonal changes were observed in the other selected morphological characters for analysis. We also did not observe consistent changes between wet and dry forms of *M. patina*. However, three of the five VHW ocelli appear to express a large white centre with thin black rings in dry season forms. Preliminary results also indicate that variations in claspers, especially in length and of the distal process, may also be important, apart from the DFWoc and VHWwDis to differentiate between polyphenic morphs of *M. mineus*.

It has been suggested that many factors such as temperature, rainfall, humidity and photoperiod may play a role in determining the wet and dry phenotypes of adult butterflies under field conditions. Sri Lanka, lacking dramatic seasonal changes in temperature, conditions such as rainfall, humidity and altitude are likely to be more important in influencing phenotypic variations in adult butterflies. We intend to perform correlation analyses between climatic and geographical variables with the morphological data, once larger numbers of specimens are collected from each species, to identify which environmental cues govern phenotypic changes and to determine which morphological characters are under environmental control.

CONCLUSIONS

This paper presents the preliminary morphometric data obtained for *Mycalesis* populations in Sri Lanka with respect to selected wing, genital and foreleg characters. These results demonstrate that there are phenotypic differences of importance concerning especially the relative size of the dorsal forewing ocelli and claspers of adult *Mycalesis* species. Furthermore, there appears to be characteristic phenotypic differences between wet and dry season forms of *Mycalesis*. Further studies are required to strengthen the analysis with larger sample sizes representing more locations covering the different elevations and climatic zones to determine the temporal and spatial phenotypic variations of species of *Mycalesis* populations in Sri Lanka.

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STUDY ON COLEOPTERAN FAUNA IN SOIL AND LITTER OF WAGA NATURAL FOREST RESERVE IN SRI LANKA

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INTRODUCTION

Fertile top soil is a valuable natural resource, forming the life sustaining layer of the earth. Due to leaf fall and semi decomposed plant materials the surface covering of the soil is known as the litter layer. Both litter and soil are favorable habitats for living organisms (Anderson, 1983). The soil contains a diverse population of arthropods. They are viewed as regulators of the decomposition of the forest.

Coleopterans are the largest order of insects, and those that are associated with soil and litter are a numerically and functionally diverse group (Dindal 1990, Edirisinghe 1997, Qader and Edirisinghe, 2012). These organisms play an integral part in the above- and below-ground food webs, and can impact litter decomposition (Witkamp and Crossley, 1966, Peterson and Luxton, 1982) and nutrient dynamics within the soil/litter interface (Lattin, 1993).

Soil and litter Coleopterans are cosmopolitan, rich in species and yet poorly studied because of their small size and cryptic habitats. However they play a major role in nutrient cycling and contribute valuable data to the study of comparative biodiversity and conservation. Due to their species richness and cosmopolitan occurrence they are used as indicator species for identifying habitat differences.(Sakchoowong *et al.*,2008).

Because of the ubiquitous distribution and functional diversity of ground and litter dwelling Coleopterans, habitat conditions and habitat perturbations could have profound impacts on their abundance and diversity.

In the view of above facts, the study was undertaken with the following objectives; to identify the litter and soil Coleopterans in three habitats, to estimate the population density of Coleopterans in three habitats and to study the correlation between physical and chemical factors with population density.

METHODOLOGY

Three microhabitats were selected in the *Indikada* Forest Reserve, Waga as the study sites, namely a disturbed site (the site which is interfered by human activities),an undisturbed site (the site which is not interfered by human activities) and a riverine site (the site which is adjacent to the river). In each study site 50m x 50m plots were selected for sampling. During the study period (September 2010 – April 2011), monthly samples of litter and soil were collected, using standard quadrant method. (0.2m×0.2m×0.1m) In each plot four soil and four litter samples were collected in a stratified random way. Additional samples were collected to determine the chemical properties (soil pH, soil moisture) and physical properties (soil temperature, wind speed, light intensity) were measured at the spot using field instruments. The soil and litter samples were investigated by extraction method, floatation method and Winkler's sieving method (for litter) to

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extract the animals and they were identified and classified by using standard keys. The data were analyzed by using Minitab programme.

RESULTS AND DISCUSSION

In all three study sites, adult and larval forms of ten Coleopteran families were observed. The identified Coleopterans belong to five major families, Carabidae, Staphylinidae, Scarabaeidae, Scolytidae and Elateridae (25-90 Number per square meter N/m²) and five minor families, Curculionidae, Phyrochroidae, Coccinellidae, Chrysomelidae and Cerambycidae (5-15N/m²).

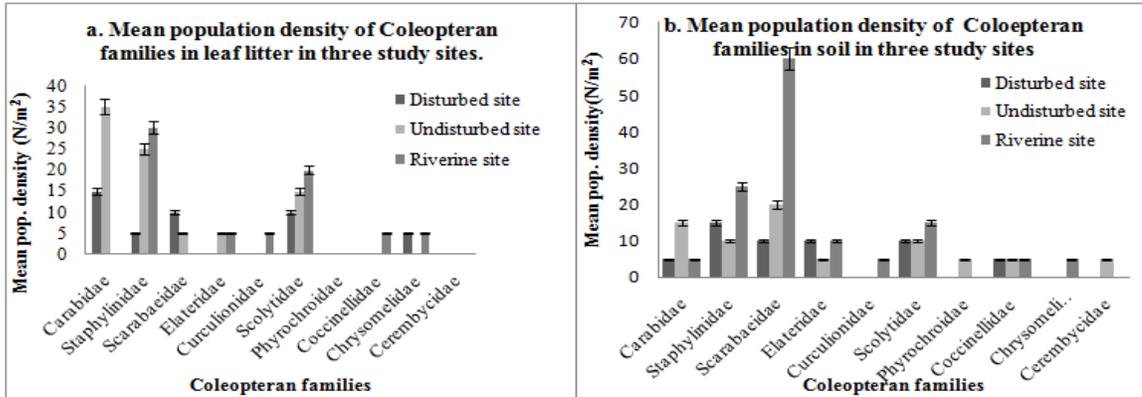


Figure 1: Comparison of mean population densities of Coleopteran fauna in litter and soil.

in litter fauna in the three study sites than the other Coleopteran families. In soil fauna Carabidae, Staphylinidae, Scarabaeidae, Elateridae, Coccinellidae and Scolytidae are the most frequently present Coleopteran families in the three study sites. Fig.1a and 1b clearly shows that the Coleopteran family Phyrochroidae was recorded only in undisturbed soil and was not recorded in the litter of any other sites.

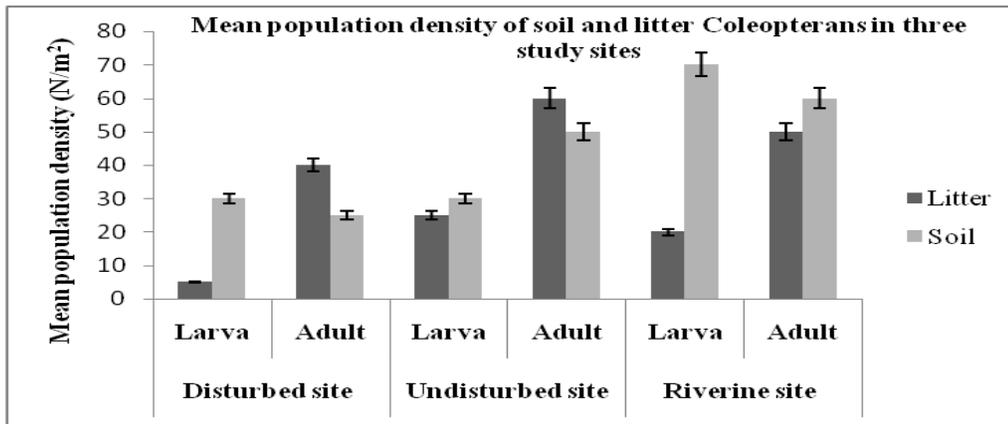


Figure 2: Comparison of mean population densities of larval and adult Coleopterans in soil and litter.

According to Figure 2, mean population density of soil Coleopterans were significantly higher ($p > 0.05$) than the litter Coleopterans ($p < 0.05$). The riverine site recorded the highest population density of soil and litter Coleopterans (260 N/m² than the disturbed and undisturbed sites (100 N/m² and 165 N/m² respectively). **THIS MAY BE BECAUSE FAVOURABLE CONDITIONS (CHEMICAL OR PHYSICAL) IN RIVERINE HABITATS SUPPORT HIGH DENSITY OF COLEOPTERANS.** Adult Coleopterans in the undisturbed site were significantly ($p > 0.05$) higher than other two sites. The same observations has been found in Sinharaja wet zone forest

and Sigiriya dry zone forest by Edirisinghe (1997). Furthermore, population density of the larval forms of Coleopterans were significantly high in the riverine site ($p > 0.05$). Correlation coefficients for physical and chemical factors and mean population density of soil and litter Coleopterans.

Table 1: Correlation coefficients for physical and chemical factors verses mean population density of soil and litter Coleopterans.

	Annual rainfall	Soil temperature	Soil moisture content	Soil acidity	Habitat type		
					Undisturbed	Disturbed	Riverine
Mean population density	-0.48	-0.57	0.35*	0.67*	0.54*	-0.12	0.78*

*Significant in 5% confidence level

The variation patterns of soil and litter Coleopterans are usually associated with changing physical and chemical factors. This variation was subjected to statistical analysis (p values) by correlation. According to Table 1, physical and chemical factors greatly influence the mean population density of Coleopterans. According to the correlation coefficients, soil moisture content, soil acidity and habitat type show significant positive correlation to high population density. When the soil moisture and soil acidity increases, mean population density of Coleopterans increased. Similar observations were reported in a study conducted previously at the same site by Qader and Edirisinghe (2012).

Mean population density showed a significant negative correlation with annual rainfall, soil temperature and disturbance. Natural conditions like, rainfall and temperature and human influence like disturbances to the forest community seems to have a negative effect on the growth and development of Coleopterans.

The population density of soil Coleopterans in the riverine site is higher than in other sites. According to the previous study conducted in the same sites, high soil acidity ($\text{pH} = 5.3 - 6.2$) was recorded in the riverine soil than in the other two sites. (Qader and Edirisinghe, 2012). Coleopteran larvae prefer acidic conditions rather than basic conditions for their survival. Therefore the high acidity level in the riverine site is more favourable to Coleopterans and may contribute to high population density of soil Coleopterans in the riverine site compared to other sites.

The undisturbed site is a natural forest type and therefore a high amount of litter is present. The high density of litter Coleopterans recorded in the undisturbed site may be due to the feeding habitats of Coleopterans, feeding on leaves and other plant debris in the litter. Therefore a high population density of litter Coleopterans was recorded in the undisturbed site. The low coleopteran densities were recorded in the disturbed site compared to the other two sites. Similar observations has been observed in disturbed and undisturbed forest land in the Amani nature reserve, Tanzania by Patricia and Theogene (2005) This indicates that when their habitat type is disturbed population density of Coleopterans is decreased.

CONCLUSIONS

There are five main coleopteran families that show vast distribution in all three habitats in the Waga natural forest reserve. The main Coleopteran families are Carabidae, Scolytidae, Staphylinidae, Elateridae and Scarabaeidae. The other five minor families recorded in these sites are Curculionidae, Phytochroidae, Coccinellidae, Chrysomelidae and Cerambycidae. The population densities of Coleopterans in soil and litter is closely related to habitat type (in riverine and undisturbed habitats population density is high).

High Coleopteran densities were recorded in riverine and undisturbed sites. High density in riverine site is completely due to soil inhabiting Coleopterans and in undisturbed site this high density is due to litter inhabiting Coleopterans. It is very clear that the high population density of larval Coleopteran forms is recorded in the riverine site. Rainfall and the population density of soil and litter fauna are significantly correlated. When soil moisture content and soil acidity increases population density of Coleopterans increases and when annual rainfall and soil temperature decreases population density increases. Therefore population density of Coleopterans is significantly correlated with changing physical and chemical factors and that indicates that they play a major role in soil ecosystems.

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A STATISTICAL ANALYSIS ON CONSUMERS' USE OF FOOD LABEL INFORMATION: A CASE STUDY OF COLOMBO DISTRICT, SRI LANKA

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INTRODUCTION

The food industry is one of the fastest moving industrial sectors. The glamorous and glittering retail shops and supermarkets are expanding very fast all over the country. The majority of food items is pre-packed and presented to the consumer in a labeled container. Label refers to a simple tag attached to the product or an elaborately designed graphic that is part of the packaging. The label provides the method by which a manufacturer communicates directly to a consumer, initially at the point of sale but also later when the product is consumed in the home. In this situation, food labels play an important role by disseminating important health and nutritional information to consumers.

This study attempts to evaluate the consumers' level of knowledge and use of information provided on food labels in making purchasing decisions. By having a better understanding of consumers' awareness and concern about information on food labels, manufacturers can market their product to meet the needs of health conscious consumers.

METHODOLOGY

Survey: This is a cross sectional study done over a period of five months at supermarkets and retail shops of various sizes in five towns in Colombo District. The geographical locations of the supermarkets, retail shops were chosen with the aim of having the maximum geographical scattering possible and also the maximum socio-economic scattering of consumers' characteristics. Participants were selected based on systematic sampling.

Data was collected using a structured, interviewer administered questionnaire. Respondents were limited to individuals age 18 and over. A total of 600 individuals participated in the survey. With the deletion of respondents with incomplete information on the variables used in the study, the final sample used contains 586 respondents.

Questionnaire: The first part of the questionnaire was aimed at assessing demographic and socio-economic characteristics of the consumer. The questions included in the second section of the questionnaire were aimed at assessing how consumers use different types of information printed on food labels and identifying which information are viewed as more important. Respondents were asked to report how often they use 18 information cues that appear on the product label for food. These were: product name, brand name, manufacture date, date of packing, expiry date, price, net quantity, country of origin, ingredient list, food additives, name/address manufacturer, direction for use/ storage, quality certificate/quality seal/ SLS, warning statement, health/nutrition claims, information about allergens, nutrition panel and trade mark. Use of these cues was measured on a 5-point Likert scale ranging from "never (1)" to "always (5)". The response categories are, "Always (5)", "Most of the time (4)", "Sometimes (3)", "Rarely (2)", "Never (1)".

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In order to measure the consumers' awareness, respondents were asked to assign the level of importance they attach to each of the eighteen categories of information generally displayed on the food labels. The response categories are; "very important (5)", "important (4)", "moderately important (3)", "of little important (2)" and "unimportant (1)".

Statistical Analysis: Two-Step Cluster Analysis using Schwartz's Bayesian Criterion(BIC) and Akaike's Information Criterion(AIC) in the Statistical Package for Social Sciences (SPSS 16.0) was used to identify clusters of respondents based on consumers' use of and level of importance attached to different types of information displayed on food labels while purchasing packaged food items. Once the clusters were identified, Chi-squared test of association was used to determine whether cluster membership was associated with individual characteristics.

RESULTS AND DISCUSSION

With respect to the socio - demographic features the survey highlighted that the majority of the respondents were predominantly women with only 26 percent as males. Nearly 37% of the respondents had a degree or above while twenty-five percent of respondents had a diploma. Individuals who terminated their education at primary level appeared to be under represented in the sample when compared to the actual population. The sample was therefore somewhat biased in terms of generalizing the results to the Sri Lankan population. Respondents were generally middle aged. More than 30% of the respondents were employed full time. The modal income category was Rs. 35000 – Rs 49999. Nearly 70% of the respondents reported children in the household 18 years or less. Approximately 5% of the respondents reported that there were children in the household under the age of one year. 74% of the sample was married; whereas the remaining proportion was single, separated/ divorced or widowed. Just over one-fourth (26%) of the respondents reported having the primary responsibility for food preparation. Nearly 47% of respondents reported buying packaged food from retail shops, while just over a third (~35%) reported buying packaged food from super markets. 17% of the respondents stated buying packaged food from retail shops and super markets both equally.

Cluster Analysis: Two – step cluster analysis identified three clusters of respondents based on consumers' use of and level of importance attached to different types of information displayed on food labels while purchasing packaged food items. The profile of each cluster in terms of median ratings of clusters on the classification is presented in figure 1, figure 2 and figure 3 respectively. Cluster 1 is the biggest(40.1%) and the least differentiated in terms of use and level of importance attached to different information cues. Median rating for the use of ingredient list, food additives, quality certificate, health claims, allergens, nutritional panel and trade mark is higher than the other two clusters; cluster 02 and cluster 03. Individuals belonging to this group scored the highest on the use of all the information cues except date of packing and showed a high level of importance. Simply they were very involved in information search printed in food labels. Additionally, they assigned a high level of importance to almost all information cues. Therefore, they might be called as "High use and High importance" in short "High, High".

Cluster 2 accounts for 35% of the sample. Individuals belonging to this segment did not actively search for information food labels. They were rather "passive" in information search printed in food labels (low score on use of most of the information). However, they assigned a high level of importance in almost all information sources except trade mark. Therefore, individuals belonging to this consumer group might be called as "Low use and High importance" in short "Low, High". Cluster 3 is the smallest consumer segment accounting for 24.9% of the sample. Respondents from this segment displayed a low use of information and low level of importance. Their usage level and level of importance assigned was lowest among the three groups. They seemed to be

very distrustful, insecure about information in food labels in general. Individuals belonging to this group did not assign a high importance to food labels and did not use any particular information in comparison with the other two clusters. Therefore, they might be called “Low use and Low importance” in short “Low, Low”.

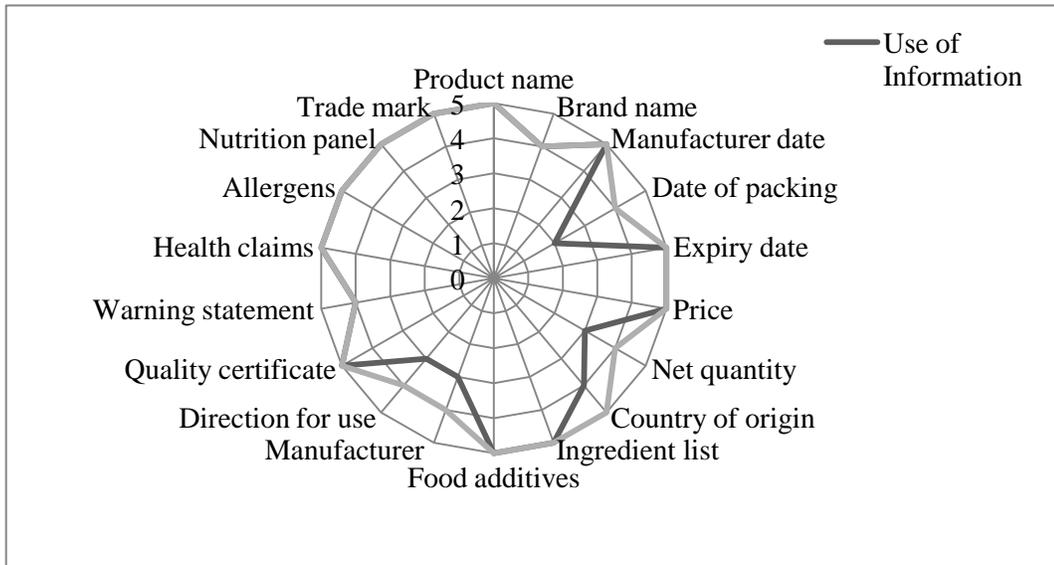


Figure 13: Cluster 01 - “high use and high importance” (median rating)

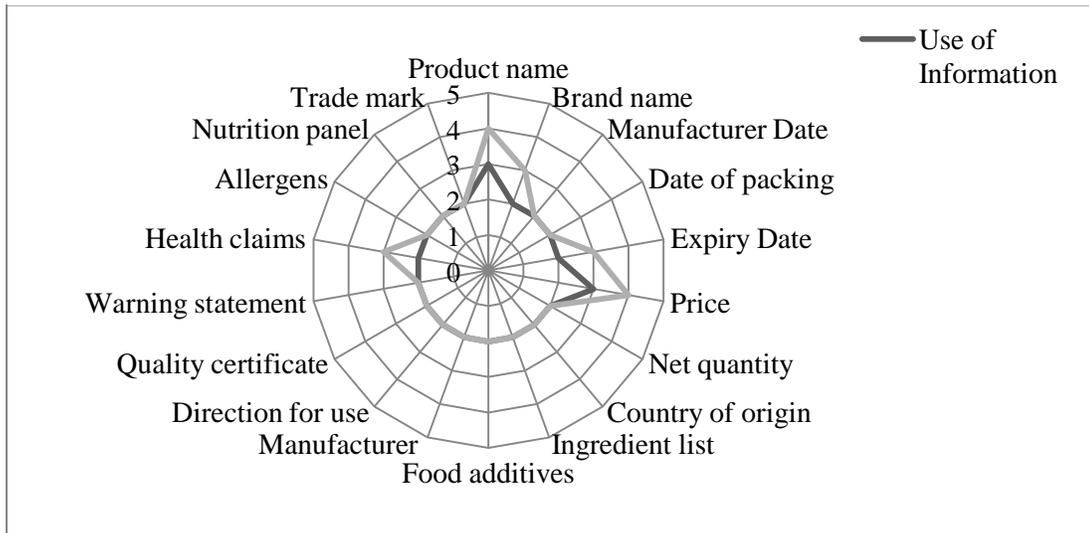


Figure 14: Cluster 02 – “low use and high importance” (median rating)

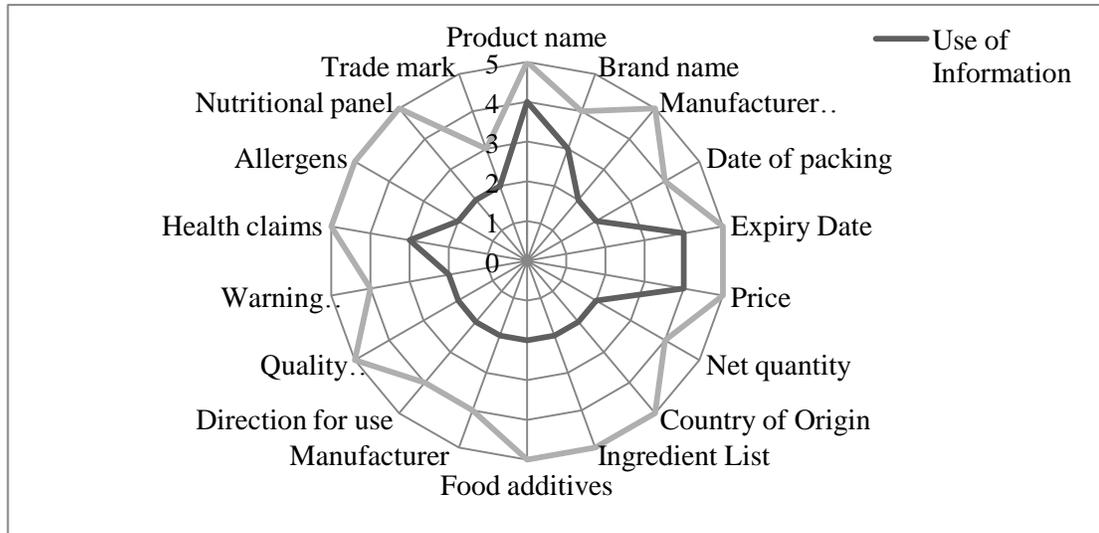


Figure 15: Cluster 03 – “low use and low importance” (median rating)

Socio-demographic differences between segments: As compared to the distribution in the total sample, there were relatively more women than men in cluster 1 (High, High) and cluster 3 (Low, Low) and more men than women in cluster 2 (High, Low). Education levels differed significantly between the clusters ($p=0.000$), with a tendency that respondents with below 0/L belonged more to the Cluster 3 (Low, Low). Significant differences between clusters were also found for the variable age. Cluster 1 showed a great concentration of individuals within the age group of 45 to 64 years. The “High, Low” consumer segment was the youngest consumer group with relatively less of the old-aged respondents and more of the younger ones. The age profile of cluster 3 was biased towards 35 – 44 year age group. An analysis of the employment status of the respondents in the sample showed that (43%) were employed full time (~21%) were housewives, (~14%) were Students and (14 %) were retired. Approximately 41% of the consumers in the cluster 02 were employed full time. The next highest proportion (~21%) was students. There was a relatively low percentage (~6%) of students in cluster 3. No significant differences were found in the household income and distribution of clusters. Significant differences between clusters were also found for the variable related to the presence of children. Cluster 1 and cluster 2 showed a greater concentration of individuals with children between ages 1 to 10 years old, while cluster 3 mainly includes respondents with children between ages 11 to 18 years old. An extremely significant ($p<0.001$) relationship was also found between marital status and cluster membership. Cluster 1 and cluster 3 contained an extremely high percentage (>70%) of married respondents. Over one-third (~37%) of the respondents in cluster 3 were unmarried. Just under two thirds (~65%) of the respondents in cluster 01 were the main household members responsible for food shopping while a significant majority (>72%) in cluster 2 and cluster 3 were the main household members responsible for food purchases. A significant relationship ($p<0.05$) was found between being the major food shopper of the household and cluster membership. A significant majority of respondents in cluster 1 and cluster 3 were the main household members responsible for meal planning. The corresponding proportion for cluster 2 was nearly sixty four percent. Significant differences between clusters ($p<0.05$) were also found for the variable related to the place of buying packaged food and clusters. Majority (~42%) of the respondents in cluster 1 reported they buy packaged food from supermarkets while just over half in cluster 2 and cluster 3 reported buying packaged food from retail shops.

CONCLUSIONS/ RECOMMENDATIONS

The results indicated satisfactory level of awareness (level of importance assigned) about labels displayed on packaged food products, however, use of such information as one of the criteria while purchasing packaged food product is relatively low. The results of the study reveals gender, highest level of education, marital status, and major food shopper of the household have significant effect on consumers' awareness and use of food labels.

It is important to draw attention to some limitations associated with the study. Due to the nature of the survey we conducted (i.e. representativeness of our sample), these results can be generalized to the population of urban areas. Ideally however future research should test the robustness of these results on semi-urban and rural population and see if there are urbanization effects. There is much larger scope to which this study could be extended and it would be very useful to determine the use of the food label information, specifically nutrition information on a much broader scale among a greater, more representative sample of Sri Lanka.

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“MATARIN YAHANATA”: POSTERS, PROPOGANDA AND FEMALE CANDIDACY AT THE 2010 PARLIAMENTARY ELECTION, AND THE 2011 LOCAL GOVERNMENT ELECTION IN SRI LANKA

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INTRODUCTION

Actress Anarkali Akarsha's controversial but successful entry into politics through the Southern Provincial Council election in 2009 was one of the contentious issues during the election year. While her suitability to hold public office was in question, her election campaign became highly publicized when she received death threats from fellow candidates and her election office in Galle was destroyed. While an analysis of the 2009 Provincial council election is beyond the purview of this study, Anarkali Akarsha's public portrayal becomes an entry point into the discussion of the relationship between gender and politics in Sri Lanka. While certain social groups such as CaFFE (Campaign for Free and Fair Elections) sympathized with Akarsha's situation, she was represented continuously by the print media as highly sexualized. An attempt to disfigure her campaign was seen through a set of posters which circulated at the time, which depicts Anarkali in a sexually compromising position, with a slogan that is equally sexual. Therefore, although Anarkali Akarsha was certainly visible during the campaign, such visibility was wrought with stereotypes of women in politics as non political, domestic and sexualized.

The above case study clearly show the challenges women face in politics, and opens up the issue of the stereotypical portrayal of female political candidates in Sri Lanka, relative to their male counterparts, and the role of the media in shaping perceptions and attitudes towards women in politics.

This becomes critical in the light of the current level of women's political participation in Sri Lanka. It reveals that although women represent 56% of the registered voters of the country, women constitute less than 6% of Parliament, 5% of Provincial Councils and 2% in Local Councils. While these statistics are the lowest in South Asia, the reasons for such low representation is perhaps due to many reasons such as the reluctance of political parties to give sufficient nominations to women candidates, the lack of systematic plans for women's inclusion in the political sphere, and women's marginalised role in economic and social development. Such limited female representation in Government is well illustrated in both the General Election in 2010 and the Local Government Election in 2011.

The General election witnessed 36 recognized political parties, 301 Independent groups and 7620 candidates. However, there were only around a hundred female contestants from all parties, the majority fielded from various Independent Parties, although a central issue raised during the elections was the need to increase female representation in Parliament by increasing the percentage of nominations for women. Finally only 13 female Members of Parliament were elected to the 7th Parliament of Sri Lanka out of a total of 225 members. Those elected included Sumedha Jayasena, Nirupama Rajapakse, Sudarshani Fernandopulle, Rosy Senanayake, Malani Fonseka, Kamala Ranatunga, Thalatha Atukorale, Sriyani Wijewickrama, Chandrani Bandara, Anoma Gamage and Upeksha Swarnamali.

The Local government elections were held in Sri Lanka on 17 March 2011, 23 July 2011, and 8 October 2011 to elect 4,327 members for 322 of the 335 local authorities in the country. The United People's Freedom Alliance's domination of Sri Lankan elections continued as expected. It won control of 270 local authorities (including two contesting as the National Congress), the Tamil National Alliance won 32 local authorities (including two contesting as the Tamil United Liberation Front), the United National Party won 9 local authorities,

The Sri Lanka Muslim Congress won 5 local authorities and a UPFA backed independent group won one local authority. There was no overall control in the five remaining local authorities but the UPFA was the largest group in three, the UNP in one and the Up-Country People's Front in one. The JVP failed to win any local authority. Only 72 women were successful in receiving nominations for the local government election. Out of these candidates, 11 women were voted into the Local Governments of their respective districts.

Therefore, the objective of the following study is to highlight the strategies and mechanisms women use to facilitate, negotiate and enhance their entry into politics, primarily through the use of posters/ advertisements and to illustrate some factors that impact on women's political representation, with a particular emphasis on the 2010 General election and the 2011 Local Government election of Sri Lanka.

OBJECTIVES

The study is two-fold. First, it looks at the profiling of female candidates in the print media through an analysis of articles, reviews, cartoons etc which the print media used to promote female political participation. Next, it examines the election posters of female candidates at the **2010 Parliamentary Election, and the 2011 Local Government election in Sri Lanka, in order to discuss how female candidates advertised themselves during the political campaign.**

The study attempts to examine the following:

1. How did print media (newspapers, in this instance) represent female candidacy?
2. Are male and female candidates of similar socio-cultural standing equally represented in the print media?
3. How and to what extent are women candidates able to challenge unfavorable media coverage and benefit from positive self profiling through the use of posters/advertisements?
4. Do the female candidates mobilize or contest clichés of women through these posters/adverts? In other words, do these posters help or hinder women's entry into politics?
5. To what extent do these posters promote sexism, gender bias or discrimination and gender stereotypes?

METHODOLOGY:

This study first analyses six of the leading Sinhala and English language newspapers published between the 19th of February and 05th of April 2010, representing government, independent and alternative views, in order to demonstrate the role of the print media in shaping perceptions and attitudes towards women candidates in the 2010 General Election. Next it analyzes the same newspapers and their representation of the female candidates at the 2011 Local Government Election, in order to discern how the print media represented women's candidacy.

While this examination will help highlight perceptions of female political leaders in the media and in society, we next focus on a random sample of election posters/ advertisements by several women candidates of the two main political parties- the UPFA and the UNP- in order to observe if women candidates benefit from the use of positive advertising content. Posters of several male candidates will also be evaluated to assess how men construct themselves in the political campaign as compared to women, further illustrating the relationship between gender and politics.

This study will incorporate feminist postcolonial theories, as those conceptualized by theorists such as Chandra Mohanty, Sara Suleri and Trinh T. Minh-ha, in the analysis of the representation of women in the newspapers, posters, and other social media under study.

DISCUSSION

The newspaper coverage of women candidates appears to be limited. Although the *Women and Media Collective* launched a nationwide campaign for both the General and Local Government election regarding the necessity to vote for women, and called on political parties to increase their nominations of women candidates in the future, the role of print media in promoting women candidates and preventing negative stereotyping of women seems detrimental. Some of the findings at the preliminary stage of this research found that the newspapers analyzed carried inadequate literature on the women candidates. Women candidates were often invisible or only covered in stereotypical ways. For instance, female candidates are often evaluated by their looks, clothing and appearance, and described in terms of their sex, children and marital status. Although some male candidates are evaluated on their appearance, fewer sex-typed images are attributed to the men, weightage given more to their ability to hold political office

With regard to the use of posters and other social media by women candidates, their representation varies in terms of how the candidates are posed. Often the female candidates use “feminine” traits to their advantage and frame themselves in stereotypical terms as mothers and wives, campaigning as female candidates rather than political candidates. Some female candidates use “masculine” and “feminine” traits while male candidates often emphasized stereotypical “masculine” traits such as leadership and competence. However, some women candidates blurred these boundaries by acknowledgement of their assumed position of the weaker sex by carrying electoral slogans that explicitly sought to contradict those positions, such as the slogan “Editharakama” (courage). Further, a preliminary study of some of the posters used by some female candidates also demonstrate a flouting of the stereotypes by the physical stances such as raised fists in posters, found on the posters of a female candidate from the North-East. But in some cases, female and male candidates are similar in their use of visuals and slogans.

CONCLUSION

As this study is still in progress, substantial conclusions on the analysis that the study yields are yet to be made. In terms of broader conclusions, this study opens up the relationship between gender and politics. Firstly, while female and male candidates, both, employ societal stereotypes in their posters/adverts, it appears that the increased visibility of women through advertisements does not always guarantee favorability and recognition. Next, the sexist depiction of women undermines women’s role in politics. Third, the use of sexualized images of women candidates in negative ads illustrates the socio cultural and gendered violence that hinders women’s political participation.

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USE OR NON USE OF MOBILE PHONES FOR AGRICULTURE BY RURAL FARMERS IN SRI LANKA (A CASE STUDY)

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INTRODUCTION

Scholars in communication for development have always emphasized the need to reach out to the most disadvantaged members of any society. They encourage providing information on innovations through media packages to be disseminated to target receivers. Of late the field has evolved into one that is defined by two conceptual models: diffusion aimed at behavior change, and participation towards social change (Waisbord, 2001; Morris, 2003). Melkote (2003) argued that there are two frameworks in analyzing development communication theories and approaches: the modernization frame work, and the empowerment framework. Though both are complementary, the empowerment paradigm or framework is emphasized in this research and applied to selected rural farmers who are already registered with two leading mobile networks, DIALOG and MOBITELE to get instant information daily on market prices of their product, paddy and vegetables in two districts in Sri Lanka.

Mobile phones are important and they also facilitate development or development process. One is that, beyond basic connectivity, mobile phones offer benefits like mobility and security to owners (Donner, 2006). Another reason is their unique characteristics, for instance, the mobile phone is a good leap-frogger: there is no need for physical infrastructure such as roads and phone wire as it works using radio spectrum (Economist, 2008). The third is that since mobile phones require basic literacy, they are accessible to a large segment of the population unlike personal computers. A mobile phone allows not only voice communication, but it also provides facilities for data transfer. This can be used in the context of applications for the purposes of health, education, commerce or governance. Therefore present research investigates how rural farmers in Sri Lanka use their phones to get agricultural information provided by two leading mobile networks in Sri Lanka, and whether such information is useful to them to uplift their lives. The following are the research questions in this research: For what purposes do farmers (men and women) paddy and agriculture use the mobile phone? How do the social factors and demographic characteristics of farmers influence their access and use of the mobile phones? What are the benefits and constraints that farmers experience from the current mobile platform? What kind of empowerment have they experienced after using the current mobile platform? What are the positive factors as well as negative aspects of services provided by two different networks? What are the type of behavioural changes that have taken place, in their home, work, environment due the use of mobile information?

METHODOLOGY

The study used the quantitative approach as it involves finding out the social, demographic characteristics of farmers, who have subscribed to the two leading mobile providers in Sri Lanka, to get agricultural information. A qualitative approach was also used as the study attempts to find out experiences of the recipients in using the mobiles and the type of empowerment achieved by rural farmers and their families which are unique and since some of these findings cannot be generalized. Therefore a questionnaire and a focus group discussion was used among farmers who were selected using a random sample.

Study Area

This study is conducted in the Southern and Eastern province and encompasses all three districts in each province namely Galle, Matara, Hambantota, Batticaloa, Trincomalee and Ampara.

Justification for selecting the study area

Having considered the highest agricultural productivity, the study areas mentioned above were selected.

Sampling Procedure

In the first stage of the research, proportionate random sampling was adapted in the selection of rural farmers of the district. The respondents will be the farmers, and their immediate families. Sample size was 200 which included 100 farmers and their families receiving agriculture market price from Mobitel telecom network and 100 farmers receiving agricultural market price from Dialoge TradeNet in Sri Lanka.

The proportionate random sample was selected accordingly.

Mobitel one hundred (100) field surveys

- Southern Province – Galle District -10
Matara District – 15
Hambantota District – 25
- Eastern Province – Batticaloa District – 10
Trincomalee District– 15
Ampara – 25

Dialog one hundred (100) field surveys

- Southern Province – Galle District -10
Matara District – 15
Hambantota District – 25
- Eastern Province – Batticaloa District – 10
Trincomalee District– 15
Ampara District– 25

Data Collection

Primary data collection

Since the focus of this research was to find out the behavior change and adoption of a new innovation and its diffusion, a field survey was conducted to gather mainly the quantifiable data, using a structured pre-tested questionnaire

Personal interview method was used to gather qualitative data with the use of an interview guide. Secondary data was collected from published materials like books, journals, newspapers, research reports about using mobiles to get agricultural information. SPSS (Statistical Package for Social Science) was used to analyze data.

Focus group discussions were held in each district representing ten (10) farmers to verify the answers given in the questionnaire.

RESULTS AND DISCUSSION

The answers given by most of the farmers surprised the researchers. It was revealed that although the main mobile networks Mobitel and Dialog have used the agricultural information for farmers for quite some time, only a few farmers have got the maximum benefit. More than half said, especially from Hambanthota District, that it was the first time they are hearing about it. Mobile phones were used mainly for functional purposes like talking to a family member, a friend or a relative and to listen to songs. SMS message service was hardly used by the farmers. Overall literacy level was very low, and most of them had gone up to level five and ten. The main benefit was keeping in touch with the outside world. Few farmers who used the agricultural information said that it helped them to know the prices in the main market, so that they could bargain with middlemen who came to buy their products for a better price. Owning a mobile phone gave them some kind of social status and recognition in the village. One of the constraints was that they had to spend their hard earned money to get this information, and it was also very impersonal in the sense, information came from a pre-recorded tape. Since the information was digitally coded by numbers, sometimes they had to wait for a long time to find out the answer for their specific question. All the farmers admitted that they considered mobiles phones, as an essential item that all of them should have. Dependence on the phone to get the day to day prices empowered them to bargain with the vendors and get a better price.

CONCLUSIONS/RECOMMENDATIONS

The conclusion is that the two service providers namely Mobitel and Dialog will have to re-think their agricultural information to suit the real needs of the farmers. Just playing a pre-recorded tape informing the market price is not enough, they should also try to net work farmers with markets, agricultural information service officers who would advice what to plant and how to take care of them various diseases, and type of manure farmers should use, and inter crops they should cultivate. It was also felt that a successful advertising campaign by the two mobile service providers is needed so farmers can get familiar with this information. As far as possible it was suggested that mobile companies should organize workshops and seminars for farmers on how to get the most benefit out of their services and specially net working with consumer markets like Cargill's, Food city and C.W.E. whole sale outlets and Keells Super, so that farmers can get a better price for their product.

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**THE J CURVE EXPOSURE: ANALYSIS OF THE EFFECTIVE EXCHANGE RATES
(EVIDENCE FROM SRI LANKA :1977-2011)**

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INTRODUCTION

This study is launched to investigate the J curve phenomenon using the effective exchange rate behavior on trade balance in Sri Lanka regarding its 10 major trading partners. These partner countries are selected by calculating the trade share for 60 countries. The top 10 trading partners are: USA, India, UK, Singapore, Japan, Germany, Hong Kong, Iran, China and Saudi Arabia. For these countries the Nominal Effective Exchange rate (NEER) and Real Effective exchange rates (REER) were constructed.

Literature: It has been found that trade in goods tends to be inelastic in the short term, as it takes time to change consumption patterns and trade contracts (Bahmani-Oskoei and Ratha, 2004). Thus, in the short run even the Marshall-Lerner condition is not satisfied, and devaluation is likely to worsen the trade balance. But in the long run, consumers will respond to the new prices, and it will improve the trade balance. This is called the J curve effect. In the Sri Lankan context, Perera (2009) has found that there was no specific pattern for the trade balance between Sri Lanka and its trading partners in response to the change in real exchange rate, and none of the cases supported the J-curve.

Objectives: The objective of this study is to investigate the impact of effective exchange rate changes on trade balance in Sri Lanka using the J curve phenomenon.

As the specific objectives the study strives to analyze the time series properties of the variables used in this study, to understand the behavior of these variables in Sri Lanka, to analyze the short run and long run effects of effective exchange rate changes on the trade balance, to investigate the existence of the Marshall Lerner condition and to suggest some policy implications.

HYPOTHESES:

Impact of exchange rate changes on trade balance.

H₀: Effective Exchange Rate changes do not affect the Trade balance.

H₁: Effective Exchange Rate depreciation improves the trade balance.

Existence of J curve ideal in Sri Lanka.

H₀: Depreciation will not improve the trade balance even though the Marshall Lerner condition holds.

H₁: Depreciation will improve the trade balance if the sum of the price elasticity of domestic and foreign demand for imports is larger than unity.

METHODOLOGY

Exchange rate and the trade balance became substantial factors with trade liberalization in 1977. Therefore the chosen study period is 1977-2011, providing 34 annual observations are employed. Data is extracted from the Central Bank (CBSL) Annual Reports, IMF Publications and *Econstat* data of the World Bank. All the data are in US Dollar Billions.

The trade share has been calculated at the first stage using the following formula.

$$TS = \frac{X_i + M_i}{X + M} \quad (2.1.)$$

Where TS: Trade Share, i: Ten partner countries

The total exports and imports to each country are divided by total domestic exports and imports. Using equation (2.1) the 10 major trading partners are selected.

Real exchange rates are calculated as nominal exchange rate adjusted for the different rates of inflation.

$$RER = ER \left[\frac{CPI_{USA}}{CPI_{SL}} \right] \quad (2.2)$$

The NEER is the weighted average of major bilateral nominal exchange rates. The weights are usually based on the trade shares, reflecting the relative importance of each of the major currencies and the Consumer Price Index (CPI). NEER Index is usually computed to reflect the changes in the foreign currency value of the domestic currency against a basket of currencies, which are important to the economy.

$$NEER = \prod_{j=1}^m r_{1j}^{w_j} \quad (2.3)$$

Where, r is the Exchange Rate of major trading partners and w will be the trade share of each country. The average increase in prices (inflation) is measured by a price index. The REER is said to measure the real exchange rate, taking into account variations of exchange rates and inflation differentials of major trading partner countries.

As the inflation rate in each country is assumed to broadly indicate the trends in domestic costs of production, the REER is expected to reflect foreign competitiveness of domestic products, given the rise in domestic prices.

$$REER = \left[ER \times \frac{CPI_i}{CPI_{SL}} \right] \quad (2.4)$$

Where, CPI_{SL} is the domestic CPI, CPI_i is the foreign CPI and r is the exchange rate.

In the calculation of these variables, Colombo Consumer Price Index, Consumer Price Indices of major 10 trading partners, Exchange rates of those trading partners, GDP of those partners are used. To understand the behavior of the variables graphical methods and summary statistics are used. The Unit Root Test is employed to investigate the time series properties of the variables. To test for stationary of a series we have used Augmented Dickey Fuller (ADF) test and the Phillip Perron (PP) test.

Then the Engel Granger co integration test is employed to understand the long run relationship. For the short run co integrating relationship, the Error Correction Model is used. The Granger causality is used to examine the short run relations among the variables employed in the balance of trade regression equation. Impulse Response Function is used to measure the trade balance behavior due to the external shocks. And this test is adopted to identify the trade balance behavior due to the external shocks to Real Effective Exchange Rate. This study attempts to develop a

similar model applied by Aziz N. (2008) for Bangladesh, in which the trade balance is a function of real exchange rate and the domestic and foreign real income. A log-linear specification of the model can be stated as follows:

$$TB = f(REER, FI, DI, PX, PM, TOT)$$

$$\ln TB = \beta_0 + \beta_1 \ln REER + \beta_2 \ln RDI + \beta_3 \ln RFI + \beta_3 \ln TOT \quad (2.5)$$

Here, $\ln TB$, indicates logarithm of balance of trade ($\ln X - \ln M$), exports and imports. $\ln REER$, $\ln RDI$, $\ln RFI$ and $\ln TOT$ are logarithm of real domestic income, real foreign income and real terms of trade respectively.

Export Function;

$$\ln X = \beta_0 + \beta_1 \ln REER + \beta_2 \ln RFI + \beta_3 \ln Px \quad (2.6)$$

Where RFI is Real Foreign Income and Px is Export price index.

Import Function;

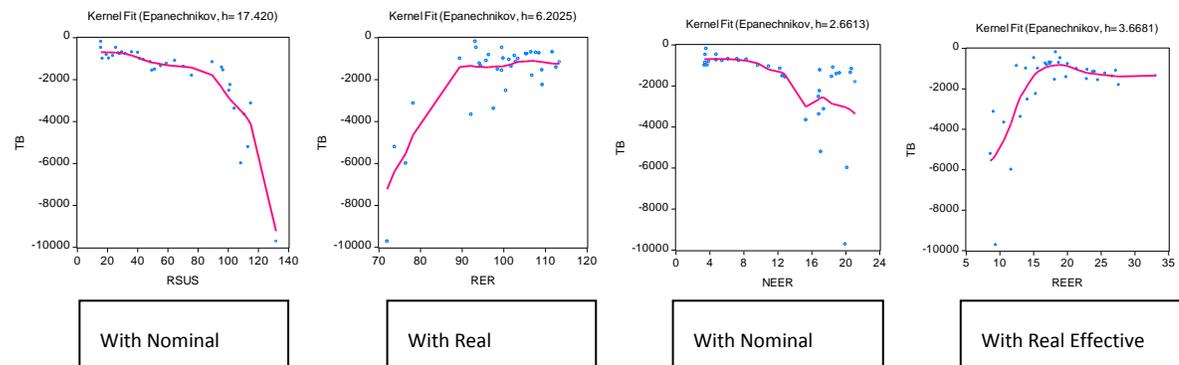
$$\ln M = \beta_0 + \beta_1 \ln REER + \beta_2 \ln RDI + \beta_3 \ln Pm \quad (2.7)$$

Where RDI is Real Domestic Income and Pm is Import price index.

RESULTS AND DISCUSSION

The impact of exchange rate policy related to depreciation of the Sri Lankan Rupee on the Trade Balance in the long run and short run has been examined using the real effective exchange rate and the nominal effective exchange rate, employing the data for Sri Lanka and its 10 major trading partners.

Engle Granger test attested that the Real Effective Exchange rate and Nominal Effective Exchange Rate do not influence the trade balance in the long run. Error Correction Mechanism perceived that the absence of short run relationship between REER and NEER on trade balance. Granger Causality test confirms that the exchange Rate does not cause the Trade Balance effectively. Marshal- Learner Condition does not exist in Sri Lanka. No evidence was found for the existence of J curve ideal and it is not applicable to any of the exchange rates.



Finally it can be asserted that neither the Real Effective Exchange Rate nor the Nominal Effective Exchange Rate can generate a significant impact on the trade balance in Sri Lanka.

CONCLUSIONS/RECOMMENDATIONS

According to the above information, exchange rate policy is not effective in the Sri Lankan case. In order to improve the trade balance, Sri Lanka has to follow some other methods. Import tax policies can be imposed to reduce imports and to increase the government revenue. Since an import elasticity of 0.876 suggests that imports are facing an inelastic demand curve. Imposing taxes on these items will generate a higher tax income for the government. The domestic income co-efficient of the Import function is 0.307 suggesting that import substitution policies should be adopted.

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THE PREVALANCE AND INCIDENCE OF TEENAGE PREGNANCIES AMONG URBAN SLUM DWELLERS IN THE COLOMBO CITY

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INTRODUCTION

A wide spectrum of literature with cross-cultural comparisons on Teenage Pregnancy (TP) illustrates that numerous issues are embedded in TP. TP is also one of the prime health concerns as its consequences are still the leading causes of death, disease and disability among young women in some countries (Sarkar 2009). Therefore, TP has become an important public health concern both in developed and developing countries. In comparison with other developing countries in the region, TP is reported to be less common in Sri Lanka. However, TP rate is increasing in Sri Lanka, especially among socio-economically disadvantaged populations, such as, internally displaced people (IDP) (Tambiah 2004), urban slums dwellers, and estate and rural disadvantaged communities (Dissanayake 2008) resulting in overwhelming medical, psychosocial and socio-economic challenges that encompass during their pregnancy and offspring (Palihawadana *et al.* 2008). Hence, TP has become an issue in certain population subgroups in Sri Lanka. However, there is lack of research on TP in the Lankan social context despite its escalating nature. Most studies on TP in the Lankan context deals with adverse health outcome of TP (Goonawardena and Waduge 2005). The previous studies have mostly been hospital based studies focusing on the TP, aiming to examine the health risks and the factors associated with TP (Goonawardena and Waduge 2005; Linganathan 2006; Herath 2007) and there is hardly any community based study on the teenagers who are from disadvantaged urban slums. Against this background, the primary research problem addressed in this paper is, what are the trends in the occurrence of TP among urban slum dwellers in the Colombo Municipal Council Area (CMC), where the largest number of slums in the country are located and from where a constantly higher prevalence of TP is reported over several years (SLDHS 2009, ARFH 2005/06/07/09). It is noteworthy that the proportion of TP in the CMC falls among the most deprived districts affected by several factors such as poverty, natural disasters and ethnic conflict. Therefore, this situation is suggestive of an in-depth analysis of the extent of the issue of TP particularly in the CMC area. However, there is hardly any macro or micro level analysis to understand the dimensions of TP in the CMC area. Therefore, an analysis of the occurrences and reasons for the variations in the occurrences of TP in the CMC area is of prime importance. Accordingly, this paper intends to describe prevalence and incidence trends of TP in the CMC area.

METHODOLOGY

Having obtained the ethical approval from the Ethical Review Committee in the Faculty of Medicine, University of Kelaniya and the managerial clearance from the relevant authorities in the CMC area, this study was conducted during 2010-2011. The study is based on the secondary data collected from the Management Information System (MIS) related to Maternal and Child Health (MCH) in the CMC area, maintained by the Maternal and Child Health Unit of Public Health Department of the CMC. The data were gathered by the principal investigator, covering the period starting from 2004-2009 using a data extraction form.

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Thus derived data were compared in order to discuss the prevalence, incidence and trends of TP in the CMC and its specific attributes. The prevalence of TP was calculated based on the data extracted from the report on Maternal and Child Health Return (RH-MIS 509) during the years 2004-2006. Although there was a need to analyze data of at least ten years in order to establish trends in TP prevalence in the CMC, the time line was restricted to 2004-2006 due to three major reasons. Firstly, the records prior to year 2004 were not available in the record room in the Medical Officer of Maternal and Child Health unit (CMOCH). Secondly, the data collection format (RH-MIS 509) had been revised in the year 2006 and implemented from 2007 onwards. This revision of the MIS in 2007 has led to a difference in TP related information. Until 2006, the target women 'under care' were reported. Nevertheless, from 2007 onwards, the 'newly registered cases' were reported. Thirdly, until 2006, a female aged 19 or less than 19 years (≤ 19 years) being pregnant was considered as TP where as from 2007 onwards a female aged 20 or less than 20 years (≤ 20 years) being pregnant was considered as TP. Hence, assuming that, these differences would affect the uniformity of data analysis, the data has been separately analysed for the period before and after MIS revision in 2007. Since the number of newly registered and the existing PTs was reported during the year 2004-2006, the prevalence (P) of TP was calculated and analyzed for this period. Likewise, the number of newly registered TPs was available in the revised MIS-RH formats from year 2007 to 2009. Hence, the incidence (I) of TP was calculated and analyzed for this period. Accordingly, the TP in the CMC is discussed using prevalence of TP during 2004-2006 and incidence of TP during 2007 - 2009. Data were analyzed using a software package called SPSS (SPSS -16.0 for Windows, 2007).

RESULTS AND DISCUSSION

The available data source related to TP is the RH-509 in which the number of pregnant mothers under 20 years is registered with an area PHM. In the RH-509 during 2004-2006, the TP under care and the total number of registered pregnancies were recorded. Hence, there was a possibility to calculate the proportion of TP under care to the number of registered pregnancy for the period 2004-2006. Accordingly calculated proportion of TP in the CMC area during the year 2004 - 2006 showed that there is sustenance in the occurrences of TP in the CMC. A regression analysis was performed to see the prevalence trend of TP. The analysis showed a trend of the total registered pregnancies (TRP) and TP under care (TPUC) in the CMC area during the period of 2004 January to 2006 June. Accordingly, two separate linear regression lines are shown with the respective trend curves. The relevant coefficients of determinants (R^2) are also shown. Although, a slight reduction in both parameters (TRP and TPUC) could be observable, the R^2 are very less ($R^2_{TRP} = 0.0829$, $R^2_{TPUC} = 0.1644$). Hence, the analysis with regard to the prevalence of TP reveals a constantly stable occurrence of TPs in the CMC area.

Incidence of TP in the CMC area was calculated using the data documented in the revised format of MIS-RH-524 from 2007-2009. Accordingly, Cumulative Incidence Rate (CIR) of TP in the CMC area is 8.5%. The CMC is divided in to six health districts. District wise analysis of TP incidence showed that, two districts in the CMC have reported CIR higher than that of the CMC (8.5%). The highest CIR is reported from the District 2A (10.5%) while the lowest CIR of TP is reported from D-4 (6.2%). Reporting of highest CIR of TP from D-2A can be attributable to various factors. It was revealed that, larger the population, higher the incidences of TP tend to be. Even though there is a natural trend towards increasing the incidence of TP proportionate to the population in some districts, some extreme cases could be observed in the CMC area. The unequal distribution of PHMM in the districts of CMC may have been a contributory factor. Although PHM per population ratio is considered to be 1:3000 in the country, the situation in the CMC is deviant from the national ratio and it is 1:7632.

Hence, non-availability of adequate number PHMM may have affected the health care service provision and health programme implementation to a certain extent in the CMC. Next, the CIR was calculated in terms of antenatal clinics (ANC) under which 96 public health midwife (PHM) areas in the CMC are clustered. Accordingly, the highest percentage of TP (11.5%) is reported from the ANC that covers PHM areas which are pre-dominantly occupied by Muslim dwellers. Accordingly, the incidence of TP can be partly attributed to the ethnic factor. The other distinct characteristic in the areas where the higher CIR of TP is reported from is that, the noticeable extent of low-income neighborhoods distribution. Hence, it is observable that the improvised living arrangements influence on the occurrence of TP in these areas. It is observable that the majority of low-income neighborhoods is concentrated in the districts such as D-2A, D-2B from where the highest incidences of TP were reported.

CONCLUSIONS/RECOMMENDATIONS

An extensive analysis of both prevalence and incidence rates of TP in the CMC revealed that the highest TP rates are reported from areas which are predominantly low-income settlement areas. Thus, a clear spatial effect on the TP within the CMC could be observed. Further, the highest TP rates are reported from resident areas which are predominated by Muslim dwellers and hence, the high incidence of TP can be partly attributable to the ethnic factor. Moreover, there was a disparity in the PHM per population ratio in the CMC compared to the national level ratio. The PHM areas where a huge disparity in the PHM per population ratios were prevalent, reported high prevalence of TP. Hence, large population size, discrepancy in PHM per population ratio and shortage of PHMM along with the distribution of low-income neighborhoods may have made cumulative effect on the incidence of TP in the CMC area. This study suggests that future studies could attempt to determine the factors associated with the differences in the prevalence and incidence of TP among districts in the CMC area. In the presence study, ethnic factor emerged as one of the key potential factors associated with teenage pregnancy. Hence, further in-depth studies could attempt to determine the association between the ethnic factor and prevalence of teenage pregnancy.

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Key Words: Teenagers, teenage pregnancy, urban, low-income neighborhoods, Colombo Municipal Council Area

DOES INTERNATIONAL FOOD PRICE INFLATION AFFECT DOMESTIC PRICE INFLATION DYNAMICS: EMPIRICAL EVIDENCE FROM SRI LANKA

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INTRODUCTION

The soaring of food prices can be devastating. It fuels inflation risks and affects the most vulnerable. It became the focus of widespread debate and policy. The people who spend a large share of their income on food will be mostly affected. The IMF's index of internationally traded food commodities prices increased 130 percent from January 2002 to June 2008 and 56 percent from January 2007 to June 2008. The risk of higher food prices was highlighted in a recent World Bank publication (Global Development Finance, 2007).

The global food prices have risen due to increase in global demand for food, declining supply on the international market, depreciation in US dollar, rising input cost (oil prices), increase in inflation expectation and rise in wage demands. Rapidly rising food prices pose important macroeconomic policy challenges for decision makers in emerging and developing countries.

Domestic food prices move with international food prices closely. These price movements lead to changes in local headline inflation, local food price inflation and inflation expectations either directly or through second round effects. The overall impact of food price increases on consumer inflation may not be proportional to the weight of food products in the consumption basket. It could be a direct and indirect price impact on overall inflation. The direct price effects are related to the weight of food in the consumer price index. Food prices have the largest weight, even now, around more than 40 percent in the average household's consumption basket in Sri Lanka. The food component counts around 67% in the Wholesale Price Index. Being an open and dependent economy, Sri Lanka is highly vulnerable to shocks in the international food prices since the food consumption basket has a large imported component (7.7% out of total imports in 2011). Recently the food share of total imports has increased. Therefore, food price increases will have a larger impact on inflation. Food has been a dominant contributor to overall inflation in the lower expenditure groups in Sri Lanka. Oosthuizen, (2007), Bhorat and Oosthuizen (2003) have also stated that food has been dominant contributor to headline inflation.

Changes in international food prices induce movements in local food, nonfood and headline prices through several channels. First, a rise in the price of international foods leads to a rise in the price of food imports. This is directly related to domestic food and headline price indices. Second, when the price of imported goods increases, consumers substitute them for local goods, due to inflation expectations. This causes inflationary pressures on local goods. Ultimately local producers focus their production for foreign market (exports) since they can sell at a higher price. Thus the supply of their goods to the local market falls. This shortage induces local prices to rise. Considering these transmission channels, several studies have empirically examined the relationship between global food prices and domestic inflation: Shawarby and Selim (2012), Jalil and Zea (2011), Van Duyne (1982), Albers et al (2011) and El-sakka et al (2005).

While a vast literature has examined the determinants of inflation in Sri Lanka, they have not investigated the role of global food price inflation on domestic inflation in Sri Lanka in depth. There exists no in-depth empirical study on international food prices and domestic inflation in Sri Lanka. This study attempts to fill this gap in the literature by examining pass-through and

spillover effects of international food prices to the domestic inflation in Sri Lanka. Therefore the main objective of this study is to investigate whether international food prices affects the domestic price inflation in Sri Lanka for the period of 2003 to 2011.

METHODOLOGY :

This study covers the period from 2003 to 2012. The study uses the year 2003 as the transition point. The post-2003 period appears to be remarkable in the magnitude of the food price inflation and in the persistence of the price increase. Monthly data for FAO food price index from FAO web site and Overall CPI index, Food CPI index and Non-food CPI index are collected from the Department of Census and Statistics, Sri Lanka. The underlying relationships and dynamic behavior of the variables are checked by line graph and confidence ellipse. Scatter with Kernel fit. Further, Engle-Granger two step residual based co-integration analysis is adopted to examine the long run equilibrium relationships and Error correction model is used to capture short run equilibrium relationships and to estimate feedback speed. Causal relationships between variables are investigated using Granger Causality test. The computer packages: E-views and Microsoft Excel are used to data analysis.

RESULTS AND DISCUSSION

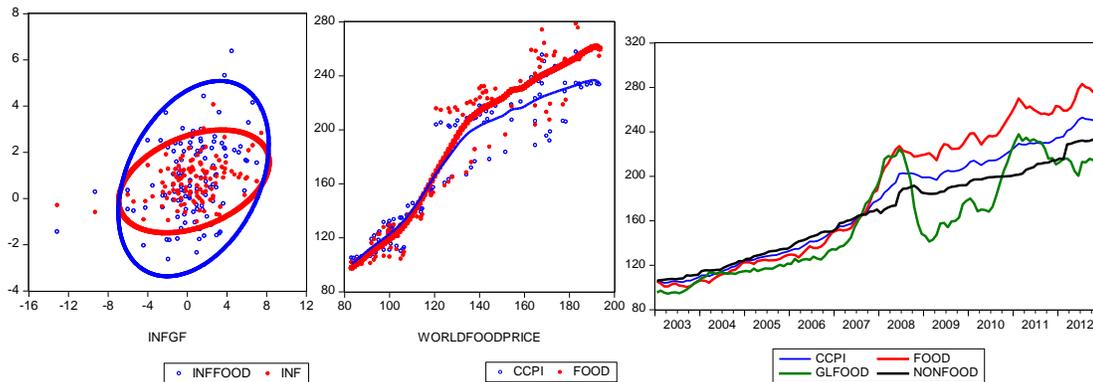


Figure1

Figure 2

Figure3

In Figure 1, the scatter diagram with confidence ellipse, shows that there is positive association between international food price inflation and local food price inflation and headline inflation. Figure 2 shows that the trend of the relationship between world food price, domestic food price index and domestic overall consumer price index. Figure 3 shows the upward trend behavior of the world food price, ccpi, local food price and local nonfood price during sample period. Global food price inflation has asymmetric effects on domestic food prices and overall price behaviour. All price series are nonlinear, non-stationary series with stochastic trend, $I(1)$. Domestic headline inflation, food inflation and nonfood inflation have been accompanied by spikes in international food prices. Food consumption basket has a large imported component (rice, flour, fish, Milk products, sugar) it is around 7-10 % of total import expenditure. Since 2007, food imports share of total imports expenditure has increased. Therefore, international food prices have been claimed that it has been their main driving factor. Local food price has been higher and increasing trend compared to global food price dynamics. However, local food prices in Sri Lanka mirrored global food price movements. Figure 2 shows that local food prices increase in higher rate than overall CCPI prices due to global food price changes. Standard deviation of each inflation rate distribution dominates the mean value. The overall shape of the confidence ellipse indicates they are positively correlated.

Simple statistical correlation analysis confirms the observed strong positive correlation ($r=0.41$) between local food prices and the global food prices. Unit root tests of ADF test, PP test indicated that all these price series are non-stationary series and integrated order one, $I(1)$. The Engle-Granger two steps co-integration test results confirm that global food inflation, local headline inflation and domestic food inflation are co-integrated, having long run equilibrium. When global food inflation increases, headline inflation and domestic food inflation also increases by 0.10% and 1.95% respectively. These positive relationships are statistically significant different from zero at 5% level. Marginal contribution of world food price inflation to headline inflation is statistically significant and economically low contribution from world food inflation to headline inflation (0.04) compared to the effect of local food inflation (0.388) to headline inflation. The contribution of Global food inflation to local food inflation is (0.195) higher than the contribution to the headline inflation. World food inflation does not statistically influence non-food inflation immediately but does significantly influence in two months lag period with the marginal effect is 0.06 with p-value of 0.03.

Error correction model results show that, global food price has positive and statistically significant response on headline inflation (0.06%) and domestic food inflation (0.10%) in the short run. However, global food price does not influence statistically significantly nonfood price inflation in the short run. The coefficient of error correction term is statistically significant and has expected negative sign in the case of headline (-0.73), food inflation (-0.65) and non-food inflation (-0.99) equations. This indicates that global food price has long run causal relationship with headline inflation, domestic food inflation and nonfood inflation in the long run. Domestic food inflation does not have statistically significant long run equilibrium relationship with nonfood inflation. However, it has statistically significant negative relationship in the short run. At the same time, domestic food inflation has statistically significant equilibrium relationship with headline inflation in the long run as well as in the short run. This implies that world food price inflation has statistically significant spillover (second round) effects on nonfood inflation in the short run not in the long run.

Granger causality analysis shows that world food inflation Granger cause local headline inflation with F statistics 7.03 and p value 0.001. world food inflation cause local food inflation with F statistic 4.37 and p value 0.014. it does not cause non-food inflation.

Pass-through of food price hikes is significantly higher than that of food price falls. Domestic price trends of food items have broadly mirrored global trends. However, while domestic prices rise in tandem with world food prices they do not tend to decline to the same extent that global food prices do. This may be owing to local market inefficiencies, domestic monopolies, and limited global trade integration.

The volatility of International food price inflation also statistically affects headline inflation the volatility series was generated using GARCH model. The coefficient of international food inflation volatility is 0.027 with probability value 0.0005. Therefore, international food price inflation not only mean level but also volatility of it affects headline inflation. The Cusum of Squares test from recursive residuals provides a plot that suggest the parameters stability in the equation during the sample period.

CONCLUSIONS AND POLICY RECOMMENDATION

The graphical analysis of this study show domestic headline inflation, food inflation and nonfood inflation have been accompanied very closely by international food prices. Local food prices increases at a higher rate than overall CCPI prices due to global food price changes. The Engle-Granger co-integration test results confirm that global food inflation, local headline inflation and domestic food inflation are co-integrated, having a long run equilibrium. Global food price does

not influence statistically significantly nonfood price inflation in the short run as well as in long run. However, world food price inflation statistically influences domestic food inflation and headline inflation. Figure 3 shows that pass-through is asymmetric, i.e. the increases in global food prices generate increases in headline, domestic food inflation while falls in global food prices do not lead necessarily to falls (see line graph, beginning of 2008). Policy attention needs to shift toward efforts to increase food production and lower the vulnerability of the poor. The surge in food prices has created and may create future adverse effects in the economy. Therefore, the Sri Lankan government must also develop a safety net program for the poor. Safety net interventions need to be made consistent with a longer term poverty reduction strategy and fiscal sustainability.

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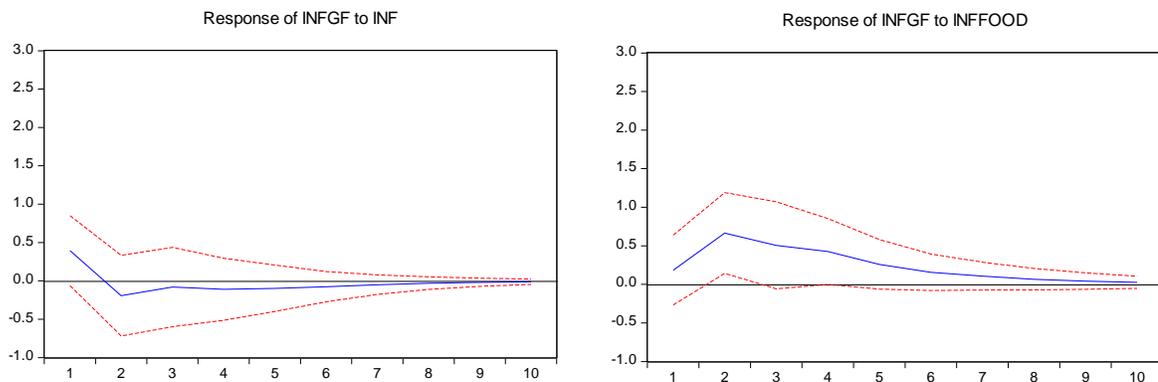
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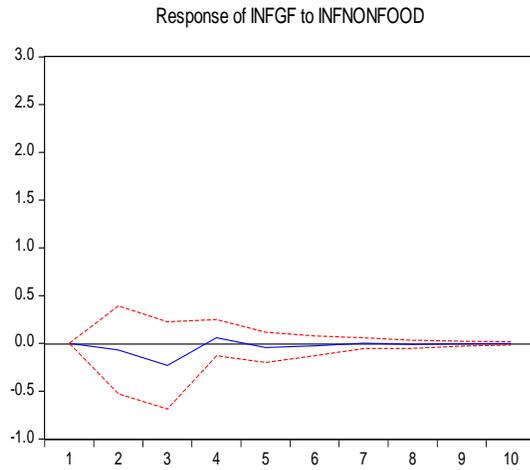
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Date: 07/29/13 Time: 21:47

Sample: 2003M01 2012M12

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
INFFOOD does not Granger Cause INF	117	5.80041	0.0040
INF does not Granger Cause INFFOOD		0.21202	0.8093
INFGF does not Granger Cause INF	117	7.03526	0.0013
INF does not Granger Cause INFGF		0.73921	0.4798
INFNONFOOD does not Granger Cause INF	117	6.56380	0.0020
INF does not Granger Cause INFNONFOOD		2.18553	0.1172
INFGF does not Granger Cause INFFOOD	117	4.37612	0.0148
INFFOOD does not Granger Cause INFGF		0.24721	0.7814
INFNONFOOD does not Granger Cause INFFOOD	117	0.23234	0.7931
INFFOOD does not Granger Cause INFNONFOOD		1.59523	0.2074
INFNONFOOD does not Granger Cause INFGF	117	3.92269	0.0226
INFGF does not Granger Cause INFNONFOOD		2.45112	0.0908

RETHINKING PSYCHOSOCIAL PROGRAMMING IN POST-WAR SRI LANKA

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INTRODUCTION

The Sri Lankan civil war began in July 1983 between the Government of Sri Lanka and the Liberation of Tamil Eelam (LTTE), a separatist militant organisation which fought for an independent Tamil state, Tamil Eelam. In May 2009 the Sri Lankan military defeated the LTTE bringing an end to the 30 year war. Many positive changes took place after this victory. People living in the South have access to the North and East. In the North and East security has been relaxed to some extent, roads and bridges are being repaired, schools and hospitals are being renovated and communities in more distant places have greater access to some of their basic necessities such as health care and schooling. The Government has launched massive development projects in the provinces where the main focus is on mobility and access. The purpose is to improve the lives of people through better infrastructure and the increased production of goods and services.

However, the Government's development and reconstruction initiatives in the North and East of the country are contributing to minority fears and alienation. Listening to the grievances of the affected communities, alleviating their suffering was not a priority in the aftermath of the end of the war.

Many organisations continued to provide psychosocial support to communities affected by the war even though they were often under scrutiny on the grounds that they were often donor driven, not always sensitive to the needs of the local populations and not long-term or sustainable. These interventions were perceived by the Government as potential threats to the victory discourse, as they collected evidence on "other" impacts of the war. Victims became "a permanent testimony" to the actual post-war environment. As a result, the political-security environment in contemporary Sri Lanka has forced psychosocial programmes to continue their efforts under the guise of other activities.

The objectives of this case study were to determine whether different conceptualizations of trauma lead to different types of interventions; whether these interventions make a difference in terms of peace building and development, or more broadly social transformation.

Given the post-war environment where psychosocial interventions are perceived as operating against national interest, the paper investigates how these interventions manage to provide services through innovative strategies in order to support the groups they work with.

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The main research questions are:

1. How do independent/non-politicized groups address the psychosocial needs of war-affected populations in the North and East of Sri Lanka within an insecure, volatile, politically inhospitable environment?
2. What are the challenges they face, and how do they overcome them?
3. What innovative practices have evolved – how do they work, and can they be applied to other post-war environments?

METHODOLOGY

The study used semi-structured interviews and responses at focus group discussions (FGDs) of managers of psychosocial programmes who were involved in the conceptualization of the psychosocial intervention (one or two per location – the total being 8 persons) and direct service providers (one or two per psychosocial programme – the total being 8 persons) and a few key informants (i.e. lawyers, counsellors, a district counsellor – the total being 5). In the focus group discussions, the participants were asked whether they felt that there was a contextual difference after the end of the war and what were, according to them the factors that contributed to the shifting context.

The individual interviews of key informants and managers and staff of psychosocial programmes were semi-structured with guiding questions to find out about the work they are engaged in, their thoughts on the changed situation of the country, the difficulties they face in doing their work and how they think their activities impact on social transformation. The data analysis methods were qualitative. The narratives were analysed and the findings were grouped according to themes related to the research questions. The research was conducted in Mannar, Jaffna, Anuradhapura and Kurunegala. The sample consisted of four psychosocial programmes, one from each location, involved in mental health and psychosocial activities and community-developmental programmes.

RESULTS AND DISCUSSION

The psychosocial interventions conducted in Anuradhapura, Mannar, Kurunegala and Jaffna mainly consisted of individual, group and family counselling. Counselling is perceived by these programmes as the most effective intervention for individuals distressed by the war. The individual is treated as part of a group or a family but he/she is the focus of the intervention. The psychosocial interventions are conceptualized with the objective of reducing the impact of trauma in the people affected by war or any other situation of violence.

The contextual change of the ground situation has not necessarily led to the reconceptualising of the psychosocial intervention either by the State or by other service providers. All four psychosocial organisations have had to face the change in context either directly or indirectly when providing psychosocial interventions to beneficiaries and through this grapple with the need for a methodological change.

During the study, due to the State of Emergency, the PTF and the reluctance to acknowledge the loss of human life at the end of the war, people of the North could not openly grieve and service providers were unable to deal with this huge loss on an individual basis. It was not possible to use the usual methodologies to deal with the kind of mass loss and trauma that was felt at the end of the war. However while a different method was used in this instance, counselling after the grieving ceremony returned to an individual focused intervention.

The organizations developed hands on approaches to their psychosocial programming as they were faced with having to deal with different types of issues such as the caste issue in the North returning into practice, the increase of rape and teenage pregnancies, easy access to other parts of the country resulting in increased needs, more disabled soldiers or loss of the sense of community for people who have resettled. These changes in contexts and the change in methodologies showed that psychosocial interventions could not follow a single pronged approach. There was also an increased awareness to broader issues like Human Rights, Patriarchy, Peace and Reconciliation.

These organisations have had to work against the ‘concept’ of justice in order to take care of the victims’ immediate needs, such as safety and security. There was an awareness to ensure that the beneficiaries’ rights are protected, but also of the risks the intervention would involve for the beneficiary i.e. the political and military connections of the abuser when trying to seek legal justice for the beneficiary. Fighting for justice was not one of the aims of the interventions. They were concerned about social justice, human rights and gender equality, but dealt with each case separately.

The individualistic nature of most interventions and the relatively short term in which service providers work with beneficiaries poses a challenge to building long lasting peace initiatives or even initiating such measures. However in certain cases these organisations through other project programmes have integrated these beneficiaries into various peace and reconciliatory actions. There was a need to advocate towards the rights of the victims if there is to be a long term solution. Advocacy, lobbying and questions on inequalities at a broader level were important aspects of psychosocial intervention.

CONCLUSION / RECOMMENDATIONS

Many psychosocial programmes operating in war-affected areas in Sri Lanka resort to counselling as the intervention to meet the psychosocial needs of their beneficiaries. Even though the interventions were very individualistic in nature, these programmes responded to broader issues such as human rights, reconciliation, peace building on a one on one basis, taking each case separately. The mission of the programmes did not envisage a need for a larger impact or had not thought about their potential to have an impact on social transformation. These programmes were very much concerned about their own survival and how they could sustain psychosocial support to their beneficiaries. The PTF was indeed a threat to the continuation of their work as it restricted the implementation of the psychosocial components of their programmes.

A programme which would include socio-economic components, a rights framework, justice and reconciliation should be developed by the Government in consultation with the different organisations providing psychosocial services. The role of the Government would be crucial in ensuring the sustainability of the services while the NGOs would be able to share their knowledge of the lives and experiences of people to develop meaningful and culturally appropriate interventions. There is a need to review the Mental Health Policy of Sri Lanka through a consultative process to ensure that it reflects the current post-war context. These interventions should ideally strive to make a difference in terms of peace building and development, or more broadly social transformation

Sri Lanka at the time of the study was “celebrating” the victory over the LTTE. Stories of losses, violence, abuses of human rights and power, alcoholism, corruption are testimonies of the experiences people have undergone and the situation of the country. By listening to the grievances of the people and studying their coping mechanisms, psychosocial programmes would be able to design interventions that would help them respond to the post-war environment.

It is important that the Government hears what people think of how they can be assisted to improve their wellbeing. This initiative would acknowledge people's ability to identify their needs and suggest ways of responding to these needs that would be meaningful to them. Of course in doing this would mean recognizing one's own vulnerability - that those in power do not necessarily know better than the victims and what is best for them.

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FACEBOOKING HALAL

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INTRODUCTION

During the past year, the “*Halal* issue”, along with other “Muslim issues” such as the *hijab* and the *purdah*, have roused much anti-Muslim sentiments in Sri Lanka. Different groups have employed different means of expressing their views on this issue. State and non-state news agencies have brought it to the notice of the community through both electronic and print media. However, the focus of this research is how these issues have been tackled or dealt with at a more informal level via social networking sites, mainly Facebook. As I see it, what you see “published” and “shared” on this virtual space is not merely a reflection of what is taking place at a more physical level in society. In *The Hyper-realism of Simulation*, Jean Baudrillard discusses how photography, mass production, television, and advertising have resulted in the creation of what he terms a “hyper-reality” that is far from the “real” world. Similarly, as a result of the greater freedom to express oneself on the online space, “facebooking”, too, leads to the construction of a “hyper-reality”, especially in relation to the “Muslim issues” that are discussed in this paper. While creating this “hyper-reality”, the action of posting information on social networking sites like Facebook also adds a certain “hyper-realistic” dimension to one’s identity, that is different from one’s “real self” in the outside world.

METHODOLOGY

The research was mainly carried out by observing a series of twenty-six images that were initially posted on Facebook and were later compiled into an email and forwarded with the title “Sinhalese, open your eyes”, which the researcher, too, received in November 2012. This material was then analysed using Gayatri Spivak’s *Can the Subaltern Speak?*, Jean Baudrillard’s *The Hyper-realism of Simulation* and Veena Das’s *Life and Words*. Since this study involves a discussion on identity, a certain amount of introspective study was also carried out.

RESULTS AND DISCUSSION

“Sharing” content on Facebook attaches a certain element to your identity, depending on the content that you “share”. Even though the material you make public is not in your own words, the fact that you choose to publish it under your name on this cyberspace makes a statement. It shapes and fixes your identity according to the party you are supporting. Therefore, even though some may see “*Halal*” or the *Hijab* and the *Burqa* as merely “Muslim issues”, this is not the case. Not only are identities shaped and created on Facebook, but the identities of both “the Sinhalese” and “the Muslims” are questioned as a result of this “Face booking”. When the researcher, as a “Sinhalese”, speak about these issues on Facebook, the questions asked are like “since when are you concerned about such matters?” and have my identity as a “Sinhalese” questioned. “The Sinhalese” must “prove” that they are “true” “Sinhalese” by sharing these anti-halal and therefore anti-Muslim sentiments on Facebook. Those who question these extremist posts are seen as either effeminate or cowardly or as unpatriotic and non-“Sinhalese”.

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An email the researcher received in November 2012 carried a series of Facebook posts exhibiting anti-Muslim sentiments. The title or “subject” of this forwarded email was “Sinhalese, open your eyes...” These online Facebook posts and the action of “sharing” them on one’s Facebook page or forwarding the email to those who sympathize with these anti-Muslim sentiments creates a sense of togetherness or group identity. Therefore it is not only one’s individual identity as a “Sinhalese” or a “Muslim” that is created, but a sense of belonging to a larger community is also instilled in the “sharer” of the information since it is addressed to “Sinhalese” and is intended to be shared amongst them. In such instances, collective identity is given prominence over that of the individual.

Interestingly, certain Muslims, too, seem to feel a necessity to prove their “true Sri Lankanness” at times when their belonging to the Sri Lankan community is questioned. When Muslims were accused of supporting Pakistan, a “Muslim nation”, during international cricket matches against Sri Lanka, certain Muslim individuals felt that they needed to defend themselves against such accusations. They, too, used the Facebook space for this purpose by “sharing” a picture of two boys at a cricket stadium holding up a poster that read “Even though we are Muslim, we support Sri Lanka”. This shows that they, too, believe that it is wrong to support any other nation when playing against Sri Lanka and that you automatically become a traitor by not doing so. Therefore the Facebook space becomes “a site of struggle” amongst different groups when it comes to proving their identities.

Following the anti-*Halal* and the anti-cattle slaughter campaigns, the next step launched by the Buddhist extremist group *Bodu Bala Sena* (B.B.S.) was the anti-*Hijab* and *Niqab* petition. Similar to the two previous anti-Muslim campaigns, this movement, too, has gained much precedence on the cyberspace. According to the Colombo Telegraph, the *Bodu Bala Sena* (B.B.S.) C.E.O. posted the following on his Facebook account on the 9th of July 2013: “Ban of face covering cloths”. He had also posted the official web link of the Government of Netherlands’ decision to ban clothing that covers the face, which states,

The government has reaffirmed the decision to introduce a general ban on wearing clothing that covers the face in public. It believes that people need to be able to look each other in the eye and interact with recognisable faces. Open communication is vital in public places. Wearing clothing that covers the face is not appropriate in an open society like the Netherlands, where participation in social intercourse is crucial.

Interestingly, such Facebook posts allow fellow “facebookers” to express their views directly and within a very short time, unlike with other forms of print and electronic media. It also creates a space for debate amongst groups with opposing points of view. The aforementioned post by C.E.O, *Bodu Bala Sena* for example, has generated comments from individuals and groups with both pro-B.B.S. and anti-B.B.S. sentiments. Some of these commenters preferred to keep their “true” identities hidden by resorting to “fake” profiles such as “Peace Lanka”, whereas others used their “real” identities and displayed a photograph of themselves in their “profile picture”. The choice of remaining anonymous or revealing one’s “true” identity is left to the facebooker, depending on how concerned they are of the consequences of their online dealings.

Speaking of identities and the ability to express oneself, it would be worthwhile looking at how Gayatri Spivak discusses the gendered subaltern figure in “Can the Subaltern Speak?”. Here, she states that the abolition of Sati or widow sacrifice in India by the British has been generally understood as a case of “White men saving brown women from brown men” (1994: 93). In the present Sri Lankan context, we are faced with a case of Buddhist men “saving” Muslim women

from Muslim men. However, it is interesting to note that the Buddhist men are not so much concerned with saving Muslim women as with saving the “nation”. In an online petition that was launched on the 10th of July 2013 urging the Ministry of Defence to ban the burka in Sri Lanka, the petitioners had stated:

We believe that the government should Ban the Burka.

It's a threat to *national* security.

This is still officially a buddhist country and it should not go out of its way to appease foreign ideologies. This isn't even just a religious symbol, considering some Islamic countries have bans It is a symbol of oppression of women in foreign countries.

We call on the government to Ban the Burka immediately. (Emphasis added)

The immediate concern of the petitioners is “national security”. It is almost as a means of justifying their actions that they state that “it is a symbol of oppression of women”. Therefore it is more about the image of the Sinhala Buddhist “nation” than about the status of Muslim women.

Whatever be their ultimate motive or reason behind the demand to ban “face covering cloths”, it is interesting that the object being discussed is women and the entire discourse is carried out by men. It is men who discuss what women should or should not wear. The Muslim woman has no voice here. In *Life and Words*, Veena Das discusses a similar situation in relation to the abduction of women during the Partition of India and Pakistan and the later restoration of these women to their families. She refers to this “restoration” of women as “a social contract between *men* charged with keeping male violence against women in abeyance” (2007: 21 emphasis in original). Similarly, in the present Sri Lankan context, the B.B.S. presents the practice of face covering as a “symbol of oppression of women”, and they seem to take it on as their duty to “protect” the Muslim women from what they see as an oppressive religious patriarchal system, while themselves advocating restrictions on dress for Sinhala Buddhist women, such as the prohibition of wearing sleeveless blouses or short skirts when entering temples.

When Spivak talks of Sati, she notes that a justification for this rite presented by the “brown men” is that “the women actually wanted to die” (1994: 93). In the Indian context that Das talks about, she points out that not only the men, but the social workers and the women’s movements, too, had assumed “that they knew best what the women’s true preferences were” (2007: 28). In the present Sri Lankan context, as a response to the accusations leveled against them by Buddhist extremist groups such as the *Bodu Bala Sena*, the Muslim men speak for the Muslim women by stating that they actually want to wear the *burka* and *niqab*. Again the Muslim woman is left without a voice and is spoken for by her male counterparts. This speaking for the Muslim women, too, is done through the online space with the use of Facebook posts.

As a response to the petition demanding a ban on face covering cloths, an online petition campaign urging “ban the BBS” was launched on the 10th of July 2013. The petition reads,

The Bodu Bala Sena has long been suppressing freedom and multiculturalism in Sri Lanka. Their actions, speeches and brutal approaches to other races and creeds in the island are not only undemocratic, but contain elements of Nazism. Under the guise of protecting Buddhism they are refusing others the right to practice and to live within the bounds of non-Buddhist life. Muslim shops are attacked, Halal packaging has been discontinued, Christian churches are attacked, and the Eucharist desecrated. Now the BBS wants to ban women from wearing the Niqab and the Burqa. *This is not Buddhist*, it is not decent, it is not human. Please sign this petition in solidarity with those who support basic dignity and the freedom to live within one’s chosen religious and cultural beliefs. (Emphasis added)

However, what is noteworthy here is that the anti-B.B.S. petitioners, like the pro-B.B.S. petitioners, have their own concept of what “real” Buddhism is. While condemning the B.B.S. for their religious extremism, the petitioners highlight that “This is not Buddhist”. Therefore they, too, become agents in constructing “Buddhist” and “Non-Buddhist” identities on cyberspace.

CONCLUSIONS

Much of the anti-Muslim religious extremism carried out by groups such as the *Bodu Bala Sena* on internet social networking sites like Facebook is at a distance from the “real” world. Jean Baudrillard discusses this phenomenon:

In his essay *The Hyper-realism of Simulation* (originally published in 1976), Jean Baudrillard asserts that the use and abundance of media, signs, and symbols has so bombarded our culture that “reality itself, as something separable from signs of it ... vanished in the information-saturated, media-dominated contemporary world” (1018). Photography, mass production, television, and advertising have shaped and altered authentic experience to the point that “reality” is recognized only when it is re-produced in simulation. Truth and reality are mediated and interpreted to an extent that culture can no longer distinguish reality from fantasy. Baudrillard terms this blurring of mediated experience and reality “hyper-reality.”

Posting anti-*Halal* and anti-*Hijab/nikab* messages on Facebook in the recent past, too, can be seen to exist at a “hyper-realistic” level. Much of the anti-Muslim hatred that we thus find on the online space is not directly expressed in the “real” world. Most people, as I myself was, are initially made aware of the existence of such sentiments via such cyberspace posts. Therefore there is a blurring of “reality” and this “hyper-reality”.

In *Simulacra and Simulation*, Baudrillard adds, quoting Littré, that “Whoever fakes an illness can simply stay in bed and make everyone believe he is ill. Whoever simulates an illness produces in himself some of the symptoms” (4). In other words, the sharing of anti-Muslim posts on Facebook and other social networking sites and web pages not only creates a “hyper-reality” in which such sentiments exist, but the act of posting and sharing these opinions in itself results in creating and making “real” such sentiments in those who might not have previously cultivated such feelings. Even though we may think that what we see on Facebook, for example, is a heightened reflection of what happens at a more physical level in “real” society, it could, in fact, be vice versa. Therefore, greater attention must be paid to this creation of “hyper-reality”, in order to better understand how it impacts “reality”.

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WHERE HAVE ALL THE TEACHERS GONE? THE POLITICS OF TEACHER TRAINING FOR UNIVERSITY ACADEMICS

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INTRODUCTION

All four authors of this paper participated in mandatory induction courses conducted by national universities for their respective academic staff in the recent past. Though we come from very different disciplinary backgrounds in the humanities and sciences all of us had broadly similar questions about the content, aims and the place of such teaching practices within the university. We were left with the uncomfortable question of whether there was an underlying utilitarian principle informing the uncritical promotion of methodologies such as learner centred teaching, reflective teaching practice and highly instrumental and positivist measurement and assessment methods. Given the larger context of declining state investment in higher education, especially in Sri Lanka, and the global commodification of education we were led to ask ourselves if these new teaching methodologies – which in essence attempt to create a more productive and efficient classroom – were part of this new orientation in higher education where the focus is shifting increasingly towards employability of graduates in contrast to the humanistic traditions of university education which seek to produce thinking, feeling and critically conscious individuals who have the potential to be agents of change, whether within their specialized professions or society at large. This paper is an attempt to explore what we feel are the historically established traditions and values of university education and to identify how, what we term, “new” teaching methodologies (we use the term “new” rather loosely because we recognize that such teaching practices have been used for at least 3-4 decades if not longer but are relatively new to the Sri Lankan university system) are potentially contributing to the transformation of the university into a limited space of quasi-intellectual exploration with more emphasis on something very close to vocational training.

THE GOALS OF HIGHER EDUCATION

Martha Nussbaum in *Not for Profit* (2010) makes an erudite, impassioned and cogent argument for the need for higher education to focus on larger humanistic goals: producing people who are critical, innovative, democratically conscious and unafraid to question and rise above conformism. These core values argues Nussbaum are important even from an instrumental capitalist-market oriented perspective, because it is a society of individuals with such values that can innovate and drive change, which even late capitalism sees as a key ingredient for sustained growth. While we do not share such an instrumentalist vision of education underwritten by capitalist logic we highlight this aspect here because of the argument often made that certain subject areas such as humanities and liberal arts are of little utility value. One central irony here though is that the Socratic principles of education that Nussbaum propounds in her text are precisely the kind of principles that inform learner-centered approaches to teaching. Reflection, which draws inspiration from the early twentieth century philosophical work of John Dewey (1933) also emerges from an anti-positivist and anti-utilitarian vision of education. However, within the current education discourse both Socratic classroom practice and reflection become methodologies that target more efficient teacher-learner interactions within often overcrowded and under-resourced university classrooms, seeking to mass-produce more and more graduates

for a marketplace hungry for disciplined and productive bodies and minds.¹ The keyword here is efficiency – with an underlying belief that as long as the proper methodology is followed learning will occur, with little or no emphasis on content and what intangible learning a student may gain through the experience of a university education. A university education is not, or should not be, limited to mere classroom or textbook education, though unfortunately this appears an increasing trend with the commodification of education. The university teacher, in this context becomes a mere facilitator and not a creator of knowledge. This is in contrast to earlier understandings where research, dissemination of knowledge and innovation have historically been central to the practice of university teaching. Today, the university teacher is increasingly becoming someone who packages skills and delivers them in an effective manner within the time, resource and institutional constraints that are imposed by the market and larger institutional realities. The Socratic classroom in this scenario translates into innocuous group work and reflection in this context also becomes an apolitical activity that is simply limited to reflecting on method. Am I being a good teacher? Are my classes well structured with clear goals and objectives? become the central questions, leaving out reflection on more contentious issues such as: What are the broader emancipatory goals of education? What kind of people are we educating? What political or ideological concerns should our students become sensitized to? Such reflection makes the classroom a potentially liberating and radical place. It is such reflection that will produce dissent, non-conformity and ultimately change and innovation. This does not imply that the role of university education is to produce rebellion but it is such a fundamentally questioning attitude that lifts university education above the mundane and everyday and turns it into a space of intellectual liberation.

THE ROMANCE OF EDUCATION

We chose the sub-title of this section deliberately and provocatively to challenge the notion of education as a utilitarian activity leading to measurable outcomes that ultimately serve a market economy. To us, education signifies something more than this. In the *Pedagogy of the Oppressed*, Paulo Freire showed that existing education systems serve the hegemonic ends of bourgeois society. Freire argued for a critical pedagogy that examined the social relations within which the pedagogical encounter takes place in order to transform it.

Arguably, student-centred teaching practice and reflective learning practices were influenced by Freire's critical pedagogy. Yet, the heart of Freire's teaching philosophy lies in his politics: the politics of social transformation which Freire argued was the purpose of the encounter between teacher and student. The absence of such a discussion in new teaching methodologies is revealing. New teaching methodologies are premised on the notion of a teacher who is a "competent craftsperson" (Pinto et.al 2012-74). Within this discourse, the teacher, the student as well as the outcomes of education are conceptualised in terms of a set of measurable competencies. This methodology is uncritically presented as the favoured and indeed, the *only* acceptable pedagogical approach. Certainly, there is merit in learning out how to plan teaching effectively and to organize learning sessions on the basis of learning outcomes. Our discomfort during the training we underwent arose from the lack of space to discuss the social and political relations such teaching encounters engender as well as lack of in-depth analysis of the context within which such teaching encounters are supposed to take place. Such a learning space arises from an acceptance that teaching is a politically neutral activity which only requires technical competence (see for instance, Finlay 2002; Finlay 2008). Even if we reject Freire's understanding of pedagogy as primarily having a transformative potential as too radical, teaching is essentially a

¹ The notion of a productive body is drawn from the work of Michel Foucault and his discussion of how institutions, especially education, serve to generate productive individuals who have internalized values that serve capital and the dominant social order (Foucault 1975: 25-26, 210-211)

social encounter. Such encounters are imbued with the social and political processes within which they are institutionalised. Gender, ethnicity, class, ideology, whether we like it or not, will influence how and what we teach. What does it mean when a discussion on teaching methods strips this encounter of its social and political connotations? For example, in a context where education policy is being reconceptualised in terms of the commodification of education, where the sole measurement of quality is in terms of the employability of graduates and disciplines which are not considered ‘marketable’ are denigrated, can there be a neutral, apolitical discussion on what we mean by educational outcomes and competencies? When we encounter highly diverse student populations with varying needs from varying social contexts, can we ignore the dynamics such diversity engenders?

New teaching methodologies focus on ostensibly more democratic and liberal teaching experiences, stressing the idea of knowledge being collaboratively constructed through a dialogue between the teacher and the student. This certainly appears to be modelled on Freire’s understanding of the essence of teaching as dialogics and dialogue. Yet also implicit in Freire’s pedagogy is the importance of social critique. What Freire terms as problem-posing education stimulates reflection and action on reality: education is an ongoing activity and a process of becoming. This involves taking humans as historical beings and taking people’s historicity as the starting point of their reflections (Freire 1970). In modern parlance, this would read as stimulating critical thinking. But, can critical thinking be stimulated by an ahistorical, apolitical and neutral teacher?

THE CHARISMATIC AND TRANSFORMATIVE TEACHER

Another practice that new teaching methodologies promote is learner-centred teaching with the concomitant reduction of the teacher’s role. The teacher as discussed earlier is reduced to a facilitator and craftsman which seems to be framed by the larger logic that a university education only requires the imparting of a certain set of skills that prepare the undergraduate for the employment market. While critical thinking is often invoked as part of this marketable package of skills, the form of critical thinking envisaged here is impoverished and often limited to something mundane like problem solving skills. While facilitating conveys a sense of collaborative knowledge production and a democratic learning space, this depends also to a large extent on the content of the learning experience. When this content is determined within market logic, the extent to which the more emancipatory and humanistic goals of education that Freire, Nussbaum and others talked about can be achieved is questionable.

While authoritarianism in the classroom is something most would decry, the charismatic teacher we feel has an important function within the university context. Charisma sits uncomfortably with new teaching methodologies because it is an often intangible and immeasurable quality leading to equally intangible outcomes such as inspiring students.

Even a cursory look at education theory suggests that the definition of a “good teacher” is highly contested. (Pinto et al. 2012) Three dominant discourses about teaching are the charismatic subject, the competent craftsman and the reflective practitioner. But as Pinto et al. (2012) argue these three discourses are invariably intermeshed with each other in actual practice and all teachers engage to some degree in all three. A fourth alternative they propose, drawing inspiration from Freire, is that of the transformative teacher. Such an individual is someone who makes the space of teaching into a critical encounter imbued with notions of social justice. A transformative teacher is able to inspire his or her students deconstruct the normative and lay bare how various political, economic, social and conceptual discourses shape what we perceive as real and normal. This is inspired from a perspective of equity and equitable social change. However, questioning the normative is not simply a political or ideological act. If we approach it from a purely

conceptual or knowledge production perspective norms still have to be questioned. Thomas Kuhn (1970) spoke of paradigm changes and how such changes are vital to the progress of science or indeed any field of knowledge. This is only possible if the normative is relentlessly questioned. Newton would have never developed the concept of gravity had he considered objects falling to the ground just a normal phenomenon. The curious scientific mind is untiringly questioning and is not satisfied with platitudes or complacent answers. The charismatic teachers we encountered shared a similar curious spirit. They may not necessarily have been transformative teachers but they have had a major impact on our lives and inspired change in us and invited us to look at life from fresh perspectives.

These teachers were rarely methodical or structured in their teaching and were essentially “unprofessional” in the sense the term is used today. But it is precisely this non-conformity and their willingness to challenge authority and convention that helped us cultivate some of these values within ourselves. They were also Socratic in the sense that they used their charisma to encourage students to question and critique. The inspiration such teaching generates is an affective quality that is not assessable but it is an intangible benefit of learning that can perhaps have more influence on a student than all the measurable learning that taking place within an institutional context. Charismatic teachers were also often the teachers who were explicit that teaching is an irreducibly political activity and that there are no neutral pedagogies. Because of their exuberance and charisma they rarely attempted to appear neutral and instead laid bare the prejudices and ideologies that drive them as individuals and in turn invited us to reflect on our own ideological makeup.

Within the current professionalisation of teaching in general and the pressure on university academics to conform to such professionalism specifically, who defines what a good teacher is and how do such definitions relate to the larger political context? The contours of the general discourse on higher education in Sri Lanka are fairly well established. The higher education ministry, officials, some sections of the general public and decision makers in the private sector see Sri Lankan higher education as archaic and non-market oriented. Funding for structural reforms in higher education by multilateral donor agencies such as the World Bank also target employability and skills that suit the marketplace. A general consensus is being created in society that the Sri Lankan university system has to undergo radical change and modernization. Even within ‘practical’ disciplines such as engineering the impression has been created that there is insufficient focus on the needs of the industry. It is within this larger institutional and political context that the new teaching methodologies are being built into the professional practice of university teachers. With this kind of dominant utilitarian thinking it is not accidental that the idea of a charismatic teacher is being displaced and more emphasis is being placed on a “competent craftsman” or a very limited notion of a “reflective practitioner”.

CONCLUSION

What we have explored in this paper are the new teaching methodologies that we have encountered in university teacher training and try to critically relate them to changing notions of higher education. Global and local higher education policy reforms are pushing for market-oriented, cost-effective higher education which focuses on producing employable and skilled graduates for the labour market. We have argued that this is a sharp deviation from the notion of higher education as having a liberating and emancipatory function. In this context, we have also considered the changing role of the teacher as an agent of social transformation to a facilitator managing class room experiences efficiently. We have shown that while learner centred and reflective teaching practices are based on radical teaching philosophies, the focus on the techniques of teaching over teaching content has stripped it of its radical and transformative elements. We argue further that this has led to the disappearance or the under-valuing of the

charismatic teacher and the potential of such teachers to inspire students and to cultivate critically questioning and intellectually challenging learning environments.

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RELAXATION BEHAVIOUR OF 1X1 RIB CORE SPUN COTTON-SPANDEX AND 100% COTTON FABRICS UNDER WASHING TREATMENTS

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INTRODUCTION

Knitted fabrics change their dimensional characteristics during relaxation and washing treatments. This results in the lessening of certain important inherent qualities of knitwear such as better fit to the body, shape retention properties, stretchability, snugness, ideality for next-to-skin wear the variations of fabric GSM, thickness and physical properties [Herath (2009), Anand, *et.al.* (2002), Mikucioniene (2001)]. It was also highlighted that these structural changes in weft knitted fabrics significantly depend on the material type, relaxation & washing treatment level and fabric structure [Anand, *et.al.* (2002), Herath, (2009), Knopten, *et.al.*(1968)]. Structural changes occurred during relaxation and washing treatments are responsible for the dimensional changes in weft knitted fabrics.

In apparel industry, *100% cotton and cotton-spandex 1x1 rib fabrics* are commonly used. Their structural behaviors are different to each other under various relaxation and washing treatments and can be determined using the changes of structural parameters. Variations of structural parameter during relaxation and washing treatments are largely due to the changes of the knitted stitch configuration [Anand, *et.al.* (2002), Knopten, *et.al.*(1968), Mikucioniene (2001)].

Knitted fabrics undergone stress resulting in stretching and various mechanical deformations during stitch formation and these stresses are released during relaxation and washing treatments. The behavior is directly responsible for dimensional stability of weft knitted fabrics. Therefore, in order to get a good quality and dimensionally stable fabric structure, a study on structural behavior is very important. This paper will be focused on the structural behavior of core spun cotton-spandex and 100% cotton 1x1 rib structures knitted with three tightness factors using circular knitting machines, during full-relaxation and repeated washing treatments (till 10th washing cycle).

METHODOLOGY

Materials

100% Cotton (abbreviation: CO) and core spun cotton/spandex (abbreviation: CO-SP) with 93% cotton and 7% spandex were used to knit 1x1 rib structures in a circular knitting machine in high, medium and low tightness factors (TF). In order to achieve better fabric properties and uniformity, tension and feed rate of cotton/spandex yarns were controlled carefully. Table I gives the characteristics of cotton and cotton/spandex yarns used for 1x1 rib structures. Spandex filaments with 40dtex were used in producing core spun cotton-spandex yarns. Table 2 gives the knitting details of 1x1 rib structure manufacturing.

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Table 1. Knitted yarn characteristics

	Nominal Count	Tensile Strength	Breaking elongation [%]	Yarn twist
CO	30*	274.4	5.04	19.7
CO-SP	30*	305	8.94	27.4

Table 2. Knitting details

	No. of feeders (positive)	No. of needles
CO	CO	1000

*Measured count of pure cotton yarn is 20.14tex and that for cotton/spandex yarn is 20.40 tex

Table 3 gives the machine set stitch lengths and machine off stitch lengths, which are measured under 95% significant level and given in parenthesis. In determining machine off stitch lengths, the *SCSL* (structural knit cell stitch length - i.e. yarn required to knit one structural knit cell /SKC) concept was used and it was assumed that SCSL equals twice the stitch lengths required to knit face/reverse stitches.

Table 3. Machine set and machine off stitch lengths in cm.

Material	Low fabric tightness [L-TF]stitch length	Medium fabric tightness [M-TF]stitch length	High fabric tightness [H-TF]stitch length
	0.290	0.270	0.250
CO-SP	(0.521 ± 0.053)	(0.489 ± 0.054)	(0.461 ± 0.066)
	0.290	0.270	0.250
CO	(0.586 ± 0.083)	(0.541 ± 0.051)	(0.502 ± 0.054)

Procedure

Sample size of 30x30 cm² were cut from 100% CO and CO-SP 1x1 rib knitted fabrics. Six samples were cut from each TF of each CO and CO-SP rib fabrics. Samples were first subjected to dry- and wet- relaxation and then subjected to full relaxation (according to ASTM D 1284-76) followed by machine washing treatments (according to the ISO6330) up to 10 cycles. For *course density* (CPC-courses/cm) and *rib density* (RPC-ribs/cm) measurements, there were 5 places selected and measured in each tested fabric sample, after being subjected to the standard atmospheric conditions. In 1x1 rib fabrics, wale spacing calculations are based on the SCSL concept. Thus, linear dimensional measurements have been calculated according to the standard method and based on that the area shrinkages were calculated.

Dimensional constants

To calculate the dimensional constants, standard procedures were used for full relaxed and washed rib structures, till 10th cycle such as SCSL (cm), stitch density (cm⁻²), tightness factor (tex^{1/2} cm⁻¹), K- constants (Ks, Kc, Kw, and Kp). CPC and RPC were measured as the mean courses and ribs per cm per face. SCSL was measured by unraveling of yarn length of 25 ribs and taking its uncrimp length with using 'Zweigle' tester by putting 0.5cN/tex weight on the underside. This weight was good enough to remove the crimp in the unraveled yarns. Five yarn lengths were measured from each sample and finally the average stitch length of 30 yarn samples was calculated with considering SCSL concept. Thus, TF was calculated using the formula ($\sqrt{\text{tex} / [\text{SCSL}/n_t]}$), where n_t- number of needles in knitting operation in one SKC.

RESULTS AND DISCUSSION

COURSE AND WALE DENSITY CHANGES

Course (CPC) and ribs density (RPC) of 1x1 rib CO and core spun CO/SP fabrics have shown different behaviors during relaxation and washing treatments up to 10th cycle (W1-W10) in Figure 1 and 2, even though they were knitted under same machine set stitch lengths as given in Table 3. According to both these figures, RPC and CPC gradually increased with the progressing of treatments. Therefore, structural spacing reduces with progression of treatments and results in dimensional shrinkages. This would also affect the variations of structural behaviors and physical properties. Thus, based on the RPC values, wale density of CO-SP rib fabrics have lower values than their course densities (CPC). But, CO rib fabrics show the opposite behavior, where it is assumed that $SCSL=2 \times \text{face or reverse loop stitch length}$. These variations may be due to the higher *robin back effect* of CO-SP structures and two planar construction of rib fabrics. Thus, RPC and CPC variations of CO-SP rib fabrics show steeper increases from full relaxations to W1 or some cases up to W3 compared to CO fabrics. After that, they show almost no variations till W10. It means that CO-SP rib fabrics became faster dimensional stable state than CO fabrics. Hence, CO-SP fabrics have given higher RPC and CPC values than CO fabrics, even though they were knitted using the same stitch lengths. This may be due to the higher robin back effect of the knitted structures and the excellent recovering properties of CO-SP core spun yarns. Thus, according to Figure 1 and 2, RPC and CPC values show positive correlation to *Fabric tightness factor* (TF) or $\text{stitch length}^{-1}$. Thus, the stitch densities of structures showed the same tendencies.

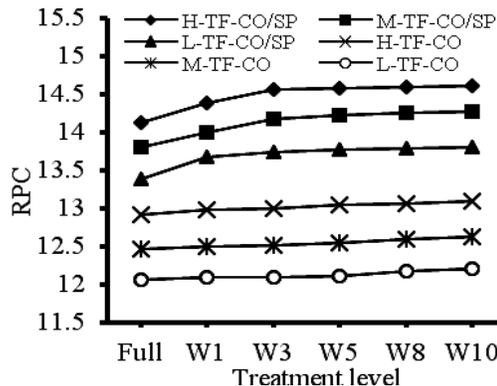


Figure 1. RPC variations of knitted fabrics

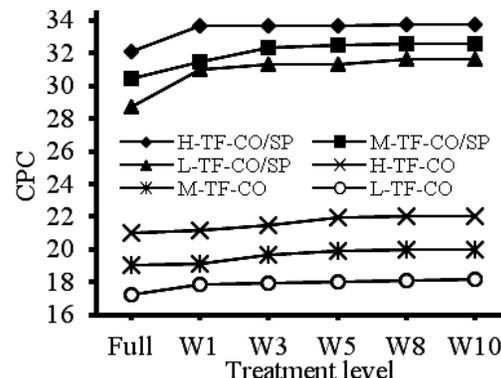


Figure 2. CPC variations of knitted fabrics

DIMENSIONAL CONSTANTS (K-VALUES)

In order to Dimensional constant values for 1x1 rib structures, following relationships about structural knitted cell (SKC) concept [Knopfen, *et.al.*(1968)] were used;

$$C_U = \frac{K_C}{l_U}; \quad W_U = \frac{K_W}{l_U}; \quad K_P = \frac{K_C}{K_W}; \quad K_S = C_U \times W_U \times l_U^2 = K_C \times W_U$$

Where C_U -Course units per fabric length(1cm), W_U -Ribs per fabric width(1cm), l_U - average total length of yarn in the SKC (SCSL). K_C, K_W, K_S and K_P are non dimensional parameters. Calculated K-values are given in Table 4 and Table 5.

CO-SP rib fabrics gave comparatively higher K-values than CO rib fabrics during full relaxation as well as in each stage of washing treatments. Almost all the K-values of CO and CO/SP rib structures are increased at 10th wash cycle. Thus, CO/SP rib fabrics show higher K-values than

that of 100% CO rib fabrics, due to its higher CPC, RPC values and higher resiliency power of spandex component in the yarn core. K_p is generally taking as a guiding rule for relaxation of weft knitted structures. When K_p becomes constant, the whole structure has achieved the minimum energy state, where no further shrinkages/deformation will takes a place in the fabric. According to the obtained K_p values: CO/SP rib structures have *Coefficient of variation* (CV %) of 2.73 at full relaxation, but, after 3rd cycle, at 5th and 8th cycles, CV% s are around 0.6 to 0.75. Then, at 10th cycle, CV% of K_p reduces up to 0.50. However CO rib structures have shown the CV% of 5.43 at full relaxation and it varies within the range of 5 to 5.42 values till 5th cycle. Then, it increases further and it reaches up to 6.29% after 10th washing cycle. Therefore, it can be understood that CO-SP structures become structurally very stable state after W10 rather than CO rib structures.

AREA DIMENSIONAL CHANGES

Linear dimensional shrinkages were calculated based on the measurements after each treatment level and then the fabric area shrinkages were determined. Those shrinkages have shown a good relation to the variations of the RPC and CPC as well stitch densities of the CO and CO-SP rib structures. Figure 3 and 4 those shrinkages. According to those figures, higher shrinkages and fabric deformations result by CO-SP fabrics than CO fabrics. In CO-SP fabrics, area shrinkages are positively correlated to the stitch length, but CO rib fabrics showed an opposite behavior. Area shrinkages are increasing with progressing of treatments. Hence, in the case of CO-SP fabrics, H-TF structures gave significantly lower area shrinkages than M-TF and L-TF structures. But, CO fabrics do not show such behaviour. Thus, after W3, most of the fabrics became dimensionally stable.

Table 4. K-values for CO/SP rib fabrics

TF	K_s	K_c	K_w	K_p	
	100.53	14.68	6.84	2.14	Full relax
	94.17	14.41	6.53	2.21	
	88.72	14.19	6.25	2.26	
	106.15	15.50	6.84	2.26	W1
	98.67	14.89	6.62	2.24	
	93.65	14.79	6.33	2.33	
	107.63	15.7	6.87	2.28	W3
	100.93	15.17	6.65	2.28	
	93.36	14.69	6.35	2.31	
	106.68	15.61	6.83	2.28	W5
	99.76	15.10	6.61	2.28	
	93.05	14.66	6.34	2.31	
	107.03	15.67	6.82	2.29	W8
	99.64	15.08	6.61	2.28	
	90.40	14.46	6.25	2.31	
	106.86	15.64	6.83	2.28	W10
	99.43	15.06	6.60	2.28	

Table5. K-values for 100% CO rib fabrics

TF	K_s	K_c	K_w	K_p	
	59.76	9.23	6.47	1.42	Full relax
	60.21	9.59	6.27	1.53	
	57.86	9.57	6.04	1.58	
	60.64	9.45	6.41	1.47	W1
	59.60	9.56	6.24	1.53	
	58.38	9.75	5.99	1.63	
	60.52	9.47	6.38	1.48	W3
	61.00	9.79	6.23	1.57	
	58.79	9.84	5.97	1.65	
	60.70	9.50	6.38	1.49	W5
	61.81	9.90	6.24	1.58	
	58.80	9.78	5.93	1.65	
	60.96	9.53	6.39	1.49	W8
	61.93	9.90	6.25	1.58	
	58.79	9.96	5.90	1.68	
	61.02	9.53	6.40	1.49	W10
	61.97	9.92	6.24	1.59	
H	58.82	9.98	5.89	1.69	

Note: TF- tightness factor ($\text{tex}^{1/2} \text{ cm}^{-1}$); L-low TF; M-medium TF and H-high TF and all values are under 95% significant level.

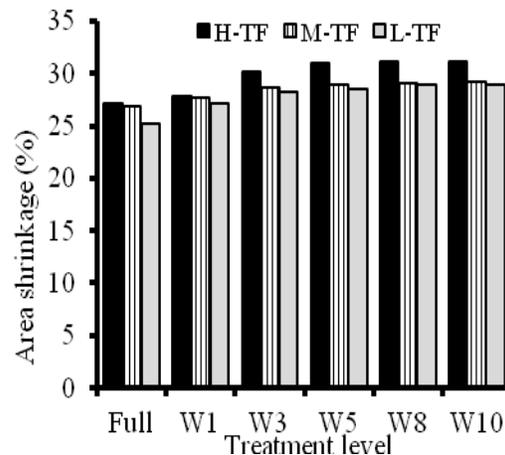
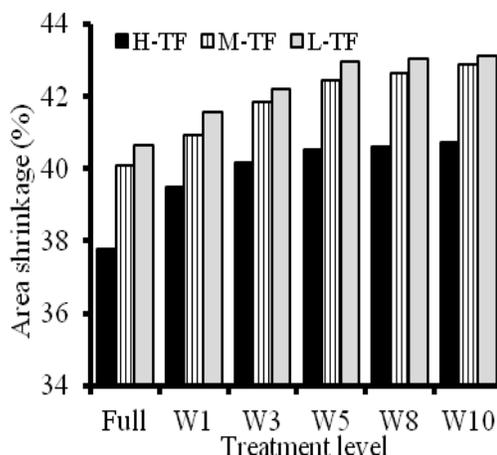


Figure 3. Area shrinkages of CO-SP fabrics **Figure 4. Area shrinkages of CO fabrics**

CONCLUSION

CO-SP rib fabrics show higher RPC, CPC, stitch densities, area shrinkages and K-values than CO rib fabrics, even though they were knitted with same stitch lengths. Thus, RPC, CPC and stitch density of CO-SP and CO fabrics give positive correlation to stitch length⁻¹. CO-SP became faster dimensionally stable (minimum of 3 washing cycles) than CO fabrics. Thus, CO-SP fabrics result higher shrinkages and fabric deformations during treatments than CO fabrics. CO-SP and CO fabric area shrinkages show the opposite correlations to the stitch length. H-TF fabrics give significantly lower shrinkages than L-TF and M-TF CO-SP fabrics.

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A STUDY TO INVESTIGATE THE EFFECT OF SEWING MACHINE SPEED ON THE SEAM STRENGTH

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INTRODUCTION

People wear various types of garments for different purposes. These garments are made by using different fabrics, sewing threads, stitch types, seam types etc. These fabrics, sewing threads, stitches and seams have different properties and characteristics. These different properties and characteristics affect the performance and the appearance of the final garments (Glock and Kunz, 1995). The joining of cut fabric panels could be carried out by using various techniques such as sewing, thermal bonding, using adhesives etc (Perera, 2006). Sewing is the most common method of joining cut fabric panels during the garment manufacture. Different seam constructions are generally used in garment manufacture to achieve the required strength, flexibility, elasticity, appearance etc in garments. These seams should have enough strength to withstand the tensional forces and abrasive forces during the wearing and cleaning. Seam strength is one of the major factors, which affects the durability of garments (Carr and Latham, 1995). The failure of seams in garments may occur due to breaking of sewing thread, tearing of the fabric at the seam, tearing of the fabric at any other place and excessive yarn slippage adjacent to the stitches or due to a combination of them.

Seam strength is generally related to fabric properties, stitch types, tension of the sewing threads, strength of sewing threads, seam types, seam allowances, stitch densities etc. Although seam strength is important, it does not need to be higher than the fabric, from which the seam is constructed (Gribaa èt al', 2006). For the construction of different seams, different types of sewing machines are used. In order to obtain high quality seams, correct sewing machine parameters should be selected. One of the important sewing machine parameters is the speed of the sewing machine. Even though research has been carried out to investigate most of the other factors related to seams, only relatively fewer research activities have been carried out to find out the effect of sewing machine speed on seam strength. Therefore, the main objective of the research is to investigate the effect of varying sewing machine speeds on the seam strength.

METHODOLOGY

1. A comprehensive literature survey was carried out to identify the factors, which could affect the seam strength.
2. Necessary materials, machines, equipment, and a suitable testing standard were selected and the parameters related to sewing were determined.
3. Fabric samples (five samples each for warp and weft directions for each machine speed) were prepared by using ten (10) different sewing machine speeds. Different sewing machine speeds in rpm (revolution per minute) were selected.
4. The samples were tested for seam strength by using the tensile strength testing machine and the necessary data was collected and analyzed to determine whether the sewing machine speed has an impact on seam strength.

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DESIGNING THE EXPERIMENT

During the designing phase, the necessary materials, machines, equipment and a suitable testing standard were selected and the parameters related to stitching were determined as given below: The table 1 shows the selected conditions for the experiment.

Table 1: **Selected conditions for the experiment**

Selected conditions for the experiment	
Fabric	Fibre content: 100% Cotton, Fabric structure: Plain weave, Weight: 76.26 g/m ² , Warp yarn count: 14.76 tex, Weft yarn count: 15.19 tex, Ends per inch: 80, Picks per inch: 49
Sewing thread	Polyester Cotton core spun sewing thread, Thread count: 36 tex
Sewing machine	Single needle lock stitch machine, Maximum sewing speed 5000 rpm
Needle	Size: 0.030 inch
Tensile testing machine	Tinous Olsun tensile testing machine (with constant rate of extension)
Testing Standard	ASTM D434
Standard conditions	Temperature: 27±2C°, Relative Humidity: 65±2%
Seam type	Plain seam
Stitch type	Single needle lock stitch
Stitch density	14±1/2 stitches per inch

The table 2 shows the selected ten (10) different speeds of the sewing machine for the purpose of preparation of the samples. This is the only variable parameter of the experiment.

Table 2: **Selected machine speeds for the experiment**

Selected machine speeds for the experiment	
Sewing machine speeds (rpm)	1750, 2000, 2250, 2500, 2750, 3000, 3250, 3500, 3750 and 4000

PREPARATION AND TESTING THE SAMPLES

The samples were prepared according to the testing standard ASTM D434. The dimension of a sample was 4"x 14" inches. As the experiment was planned to be carried out in both the warp and the weft directions, samples were cut accordingly. After cutting the samples, they were folded 4" from one side, parallel to the shorter direction. A seam was created by applying a row of stitches, half (½) inch away from the folded line of the sample. For each of the chosen machine speed ten samples were sewn. Of these ten samples, five were sewn with seam parallel to the weft direction and the other five with seam parallel to the warp direction. Thus the total number of samples prepared was 100 for the 10 different sewing machine speeds.

The prepared samples were tested by using the selected tensile strength testing machine. For the testing purposes an extension range of 50 inches, testing speed of 11.81 inches per minute, 100 lbf (pound force) load and 1.0 lbf preload was used. The seam opening was 0.252 inches

RESULTS AND DISCUSSION

Table 3 and 4 give the seam strength of each sample tested in seam parallel to the weft direction and the warp direction respectively.

Seams parallel to weft direction

Table 3: Seam strength of samples – Seam parallel to weft direction

Machine speed (rpm)	Seam strength in lbf					
	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Average
1750	37.86	32.27	35.88	38.35	37.82	37.44
2000	35.70	34.31	36.24	36.87	36.69	35.96
2250	35.74	37.32	36.10	35.61	36.19	36.19
2500	36.55	38.13	35.97	38.72	36.87	37.25
2750	39.66	37.09	37.43	37.27	37.60	37.81
3000	38.40	34.89	33.33	36.55	37.59	36.15
3250	33.89	32.32	37.72	36.96	32.19	34.62
3500	36.60	39.96	38.67	33.86	37.98	36.81
3750	39.52	35.07	30.03	37.82	37.99	37.89
4000	34.44	37.22	35.74	39.34	35.30	36.43

Seams parallel to warp direction

Table 4: Seam strength of samples- Seam parallel to warp direction

Machine speed (rpm)	Seam strength in lbf					
	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Average
1750	18.01	19.87	21.85	19.31	19.38	19.68
2000	21.99	17.80	17.65	17.76	19.78	19.00
2250	19.47	18.03	19.02	20.05	22.68	19.85
2500	16.46	24.64	19.47	23.10	20.10	20.75
2750	16.01	21.42	19.81	23.04	21.85	20.43
3000	18.50	18.43	16.59	18.37	21.84	18.74
3250	18.88	20.28	18.84	16.10	18.95	18.61
3500	19.74	19.11	15.31	18.07	17.45	17.94
3750	19.02	18.28	18.57	19.33	18.41	18.72
4000	21.67	20.25	19.08	19.16	20.10	20.05

The last columns of Table 3 and 4 show the average value of seam strength for each tested machine speed. The overall average value of seam strength for the selected sewing machine speeds in the weft direction is 36.65 lbf, and in the warp direction is 19.37 lbf. The standard deviation and the percentage of the coefficient variation of the average values for the samples where the seam is in the weft direction are 0.94 and 2.56 respectively. Similarly the standard deviation and the percentage of the coefficient variation of the average values for the samples where the seam is in the warp direction are 0.85 and 4.38 respectively. As per the results, it is could be established that there is no significant change in the seam strength at different sewing machine speeds, both when the seam is parallel to the weft and the warp directions.

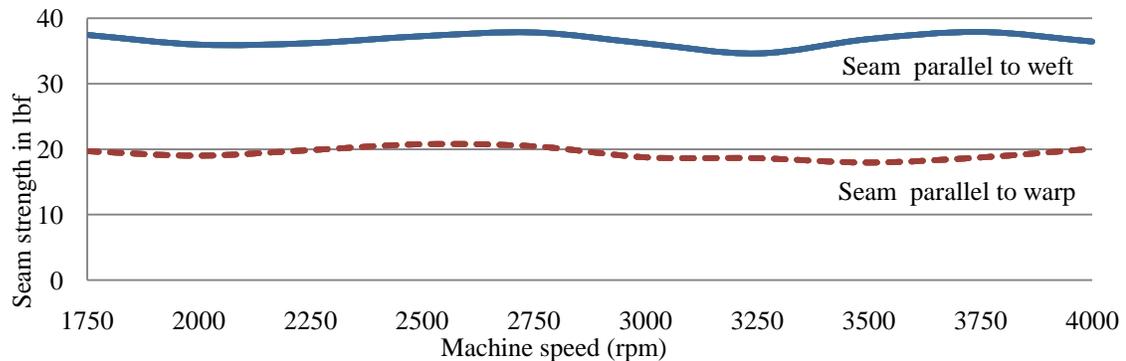


Figure1: Variation of the seam strength against different sewing machine speeds

The average strength of the seams parallel to weft direction is higher than the seams parallel to warp direction as the number of ends per inch is higher than the number of picks per inch in the selected fabric. The changes within single direction are not significant.

CONCLUSIONS AND RECOMMENDATIONS

The sewing machine operators use different sewing speeds during sewing of garments. The criteria for using different speeds is dependent on the skill level of the operators, nature of the fabrics, shape of the stitching lines (curved or straight), the length of the seams, limitation of the sewing machine speeds etc. During the sewing process, the needle penetrates the fabric panels at different speeds as sewing machine operators use different sewing speeds. Therefore it is possible to think that with the increase of the sewing machine speeds there is a possibility of reducing the seam strength. As per the results obtained from the samples made parallel to the weft and warp directions, it is difficult to establish a pattern for the seam strength variations against different sewing machine speeds. Low values of standard deviation and percentage of coefficient of variation prove that the changes in the average values of the seam strength at different sewing machine speeds are insignificant.

Therefore, based on the results of this research, it is possible to conclude that the variations of sewing machine speed do not have significant impact on the seam strength. Therefore it is possible to recommend that the higher sewing speeds could be used for sewing purposes to achieve higher sewing efficiencies as there is no significant change in seam strength.

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CONCEPT NOTE; A CONSTRUCTED WETLAND TO MINIMIZE THE POLLUTION CAUSED BY KARADIYANA SOLID WASTE DUMP

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INTRODUCTION

Municipal solid waste (MSW) consists of different organic and inorganic fractions like food, vegetables, paper, wood, plastics, glass, metal, construction debris etc. MSW has a considerable impact on ecosystems, and poses threats to human health and well-being. Waste also threatens the integrity of habitats that are essential to biological diversity. Uncontrolled open dumping of MSW in environmentally sensitive places, due to non-availability of required investment to construct and operate engineered solid waste management processes, is causing a considerable damage to the environment, specifically to neighbouring natural water sources. Karadiyana solid waste dump, situated in Thumbovila Village close to Piliyandala, is a perfect example for this.

Two Municipal Councils and two Urban Councils dump their daily collection of MSW at the Karadiyana dump site occupying 25 acres of land. A substantial portion of leachate generated by the dumped MSW flows directly to a stream which bisects the dump site as depicted in Figure 1 and the rest infiltrates in to the ground polluting the ground water. This stream flows directly to Weras Ganga, which is a tributary of Bolgoda Lake, presumed to be the largest natural lake in Sri Lanka. The Bolgoda Lake has an eco system, which is rich in bio diversity. Leachate originating from the dump site thus ends up in the Bolgoda Lake endangering this eco system thereby threatening the livelihood of the community depending on the leisure industry, fishing and all other activities associated with the lake.

Plans to establish a composting plant and to generate power utilizing MSW are in the pipeline. However, the pollution caused by leachate goes unabated. This study presents a low cost solution to improve the effluent quality of stream water by passing contaminated water of the stream through a constructed wetland to reduce the levels of pollutants.

PROBLEM IDENTIFICATION



Operated initially by a private company, unsorted MSW had been dumped on a flat land without proper mechanisms to prevent mixing of generated leachate with surface and ground water. No control other than covering the waste with soil from time to time to minimize the smell and to reduce the nuisance caused by disease vectors had been done. Conditions have improved since the current operator of the site, Waste Management Authority (WMA), has taken over the operations of the site. They have sub-divided the site into several cells and the dumping takes place in a controlled sequence. Licensed operators are permitted to collect

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recyclable waste like plastic bottles, glass, scrap metal etc. which reduces the amount of non biodegradable waste.

However, part of leachate generated by the MSW infiltrates in to the ground and the remainder flows to the stream and no measures have been taken to contain the pollution caused by leachate. Ideally, at the initial stage before dumping MSW, an impervious barrier should have been provided to prevent contamination of ground water from infiltrated leachate. Now, that MSW has been dumped up to 10m high in some locations, it is almost impossible to completely contain the infiltration of leachate to ground water. However, measures can be taken to minimize the contamination of surface water and to reduce the degree of leachate infiltration.

METHODOLOGY

A “constructed wetland” is proposed as the solution which requires a nominal cost to construct and utilizes natural materials available from the vicinity to remove pollutants through a biological process without consuming expensive energy.

Logic used in the study methodology

“Constructed wetlands are either free water surface systems (FWS) with shallow water depths or subsurface flow systems (SFS) with water flowing laterally through sand or gravel. Water hyacinth (*Eichhornia crassipes*) has been studied extensively for use in improving the wastewater effluent from oxidation ponds and as the major component in an integrated, advanced wastewater treatment system. The major characteristics of water hyacinths that make them an attractive biological support media for bacteria are their extensive root system and rapid growth rate” (Design Manual, 1998).

Water hyacinth, ranked as one of the world’s worst invasive water weeds, could be put to good use due to the above mentioned properties under a controlled constructed wetland system. Bacteria attached to plant roots, stems and leaf litter are the major factors for BOD₅ removal. FWS system is the suitable constructed wetland system to make best use of this advantage.

Treatment process proposed for the stream water contaminated with leachate is shown in Figure 2

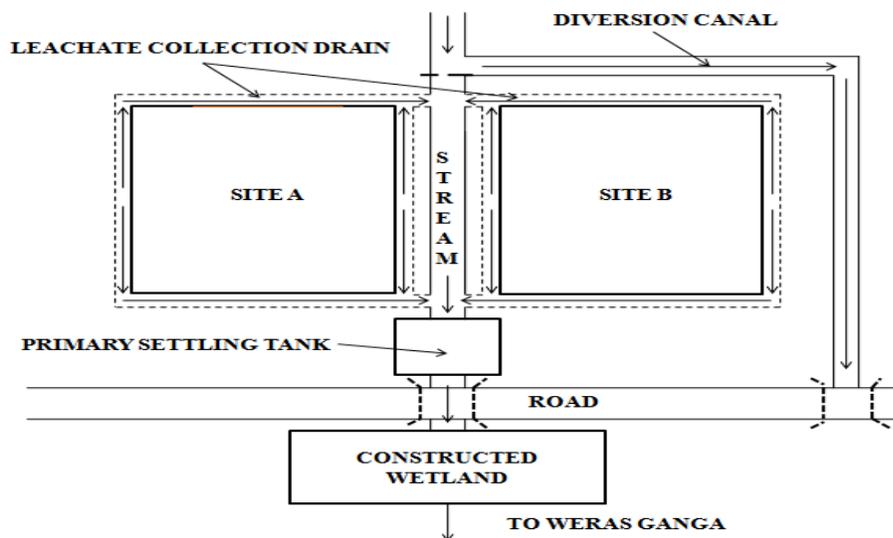


Figure 2 – Proposed treatment process

Proposed Treatment Process

Construct a weir on the upstream side of the stream and a diversion canal to regulate the flow of water through the stream so that the flow through the stream is constant throughout the year. Excess water will flow directly to Weras Ganga through the diversion canal without coming into contact with leachate.

Construct surface drains around the two sites to collect as much leachate as possible to minimize the infiltration.

Send the stream water mixed with leachate through the primary settling tank to reduce the load of Total Suspended Solids (TSS). This improves the efficiency of the constructed wetland. Scrape off the settled solids in the primary settling tank from time to time and dispose together with MSW to recycle.

Send the effluent from the primary settling tank through the constructed wetland (Figure 3). Send the effluent from the constructed wetland to Weras Ganga.

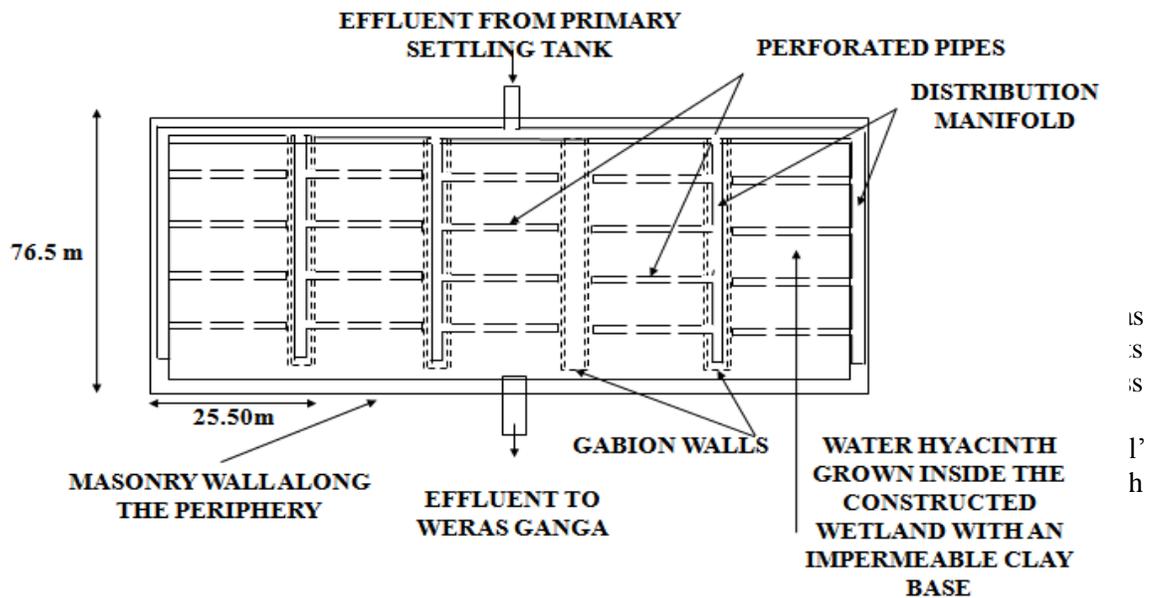
Length of the constructed wetland is governed by the available distance between the road and the Weras Ganga which is approximately 80m. Hydraulic loading rate was evaluated to match this constraint in order to have the required levels of pollutants in the effluent and the design required five fully vegetated FWS cells. Step feeding method was employed to maximize the efficiency (Design Manual, 1988) since the pollutant removal percentage is higher within the initial part of the wetland. Recycling was not considered to minimize initial and operating costs of the process. Design process of the proposed constructed wetland (Deepika, 2012) is not covered here due to space limitations.

RESULTS AND DISCUSSION

Table 1 indicates the current levels of pollutants present in the stream water obtained from laboratory tests, corresponding values of pollutants after going through the proposed treatment process (Design Manual, 1988) and the maximum tolerance limit of each pollutant type (Technical Guidelines, 1990).

Table 1 – Levels of Pollutants

Pollutant Type	Current Pollutant Level	Pollutant Level after Treatment	Maximum Tolerance Limit
Biochemical Oxygen Demand - BOD ₅ (mg/l)	171	30	30
Total Suspended Solids – TSS (mg/l)	448	50	50
pH value	7.3	7.3	6.0 to 8.5
Chemical Oxygen Demand – COD (mg/l)	497	247	250
Chromium – Cr (mg/l)	0	0	0.1
Copper – Cu (mg/l)	0.01	0.0025	3.0
Lead – Pb (mg/l)	0	0	0.1
Nickel – Ni (mg/l)	0.015	0.00375	3.0



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