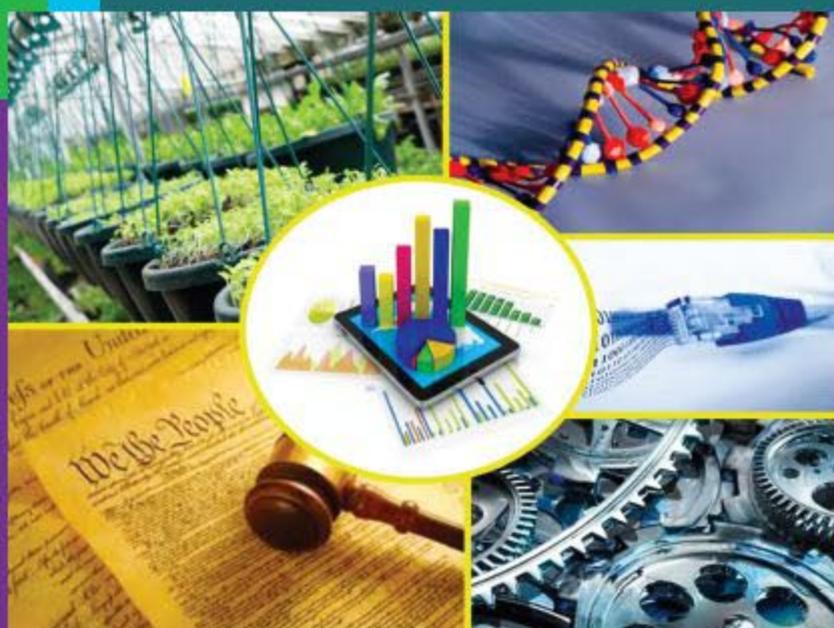




Annual Academic Sessions - 2014



PROCEEDINGS

The Open University of Sri Lanka
November 27 & 28



**THE OPEN UNIVERSITY OF SRI
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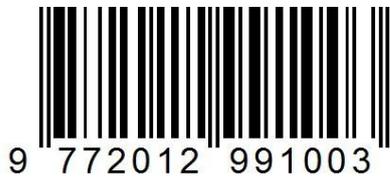
**Extended Abstracts
Annual Academic Sessions
27 - 28 November, 2014**

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MESSAGE FROM THE VICE CHANCELLOR

I am pleased to send this message to the Proceedings of the Annual Academic Sessions 2014 of the Open University of Sri Lanka (OUSL). The Annual Academic Sessions of the OUSL symbolizes the zenith of efforts and results of research conducted by the academics of the university. The academic sessions have been held each year since 2003, and they have provided an opportunity for academics to disseminate their research findings and to exchange views with their colleagues. I hope that the deliberations and discussions of this research forum will not only serve as a source of information but also throw light on new areas worth further study.

I am happy that the OUSL is continuing with its mission to enhance access to high quality, affordable and relevant education through Open Distance Education while ensuring its research potential to the advancement of knowledge and national development through conducting this kind of activities annually. I am sure this year's Annual Academic Sessions will be an excellent platform for academics and researchers from the OUSL together with other universities and research organizations to present their research, share experiences, and to advance their knowledge with the latest developments in the respective disciplines.

I express my appreciation to the Senate Sub-Committee on Annual Academic Sessions 2014 for their hard work and commitment to make this event a success. I wish the Annual Academic Sessions 2014 of the OUSL will be an academically fruitful event for all the presenters and participants.

Dr. Vijitha Nanayakkara

Vice-Chancellor

PREFACE

It is my pleasure to present the published Proceedings of the Annual Academic Sessions, 2014 of The Open University of Sri Lanka. The research findings accepted for presentation at the Annual Academic Sessions on 27th and 28th November are published in this volume.

The extended abstracts published in the Proceedings of the Academic Sessions 2014 are the work of researchers from both within and outside the Open University. This year, 130 extended abstracts were received, of which 90 research papers were accepted for presentation, after a peer review process. As in previous years, the papers presented in this year's Academic Sessions include Open and Distance Learning (ODL) studies as well as research and development in a wide variety of contemporary topics relating to Natural Sciences, Engineering, Education, Humanities and Social Sciences. The proceedings published in this volume are classified into 12 areas as shown in the contents and reflect the diverse range of the accepted research papers. It is my firm belief that the initiative taken by the Open University to make the Academic Sessions an annual event in the university calendar has contributed to strengthen the research and development activities of the university, and thereby contributing to the national development of Sri Lanka.

On behalf of the Senate Sub-Committee, I take this opportunity to thank the authors of the research studies for their valuable contribution and cooperation in preparing and finalizing the extended abstracts within the given time frame. Our sincere thanks go to the 287 referees who reviewed the extended abstracts with utmost care. We are also grateful to the panel of reviewers, who spent their valuable time to evaluate the research publications for the "Annual Research Awards - 2013".

The Senate Sub-Committee wishes to acknowledge the team of language editors from the Department of Language Studies and Postgraduate Institute of English of the Open University of Sri Lanka. The secretarial assistance given by Miss. Achini Kandana Arachchi and Miss. Nayana Wijesinghe and Mr. Priyantha Nawarathne for Desktop Publishing of the Proceeding is especially appreciated. On behalf of the Sub-Committee I express my gratitude to the cooperation extended by the staff of the OUSL Press in printing this volume, staff of the Deputy Registrar's (Academic) office and all others who helped us in numerous ways to successfully organize the OUSL Annual Academic Sessions, 2014.

The active participation and contribution of all members of the Senate Sub-Committee was essential for organizing the Academic Sessions and I sincerely thank the 2014 team for all their efforts and the support extended to me as the Chair.

My best wishes for intellectually stimulating and productive deliberations at the Annual Academic Sessions, 2014.

Professor Kolita Weerasekera

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CONTENTS

PAGE

Message from the Vice-Chancellor -----	i
Preface -----	ii
Organizing Committee of Annual Academic Sessions -----	iii
List of Reviewers -----	iv
Session Chairs -----	vi
Paper Categories -----	vii

AGRICULTURE

1. EFFECT OF MULCH ON SOIL PROPERTIES AND YIELD OF GROUNDNUT PLANTS EXPOSED TO TEMPERATURE STRESS <i>G.V. N. Aiome and C.S. de Silva</i> -----	01
2. EGG QUALITY PARAMETERS OF FRIZZLE AND NAKED-NECK FRIZZLE CHICKEN GENOTYPES UNDER DIFFERENT DIVERSIFICATION SYSTEMS <i>E. Subalini, S. Thanuejah and S. Elango</i> -----	05
3. IMPACT OF MULCHES ON PHYSIOLOGICAL PARAMETERS OF TOMATO (<i>Solanum lycopersicum</i> - variety Thilina) AT DIFFERENT GROWTH STAGES EXPOSED TO HIGH TEMPERATURE AND WATER STRESS <i>P.T.N. Dishani and C.S. de Silva</i> -----	09
4. ECOTOXICOLOGICAL ASSESSMENT OF SOME SELECTED WEEDICIDE FORMULATIONS ON <i>Eisenia Andrei</i> UNDER TROPICAL CONDITIONS <i>S.P.K.C. Hansani and P.M.C.S. De Silva</i> -----	13

EDUCATION

5. SCHOOL BASED INSTRUCTIONAL SUPERVISION PROCESS: ISSUES ENCOUNTERED BY SUPERVISORS AND TEACHERS. <i>W.M.S. Weerakoon</i> -----	17
6. PERCEPTIONS OF DIFFERENT STAKEHOLDERS ON READINESS OF CHILDREN ENTERING GRADE ONE <i>D. Lekamge and B. Withanage</i> -----	22
7. THE NEED FOR PLANNING SECONDARY EDUCATION TO DEVELOP VOCATIONAL-ORIENTED COMPETENCIES TO MEET THE NEEDS OF THE WORLD OF WORK <i>W.M.S. Wanasinghe</i> -----	26

8. HOW DOES COOPERATIVE LEARNING HELP TO INCREASE COMMUNICATION AMONG STUDENTS IN SCIENCE LEARNING?
T. Sakeetharan and T.M.S.S.K. Yatigamana----- 30
9. CAN THE COMPLETION RATE OF A COURSE BE INCREASED BY LOWERING THE ELIGIBILITY CUTOFF MARK IN CONTINUOUS ASSESSMENT?: A CASE STUDY
G. Bandarage----- 34
10. A COMPARATIVE STUDY ON THE SUPPORT RECEIVED BY STUDENT TEACHERS DURING THE TEACHING PRACTICE STAGE 1 OF THE POST GRADUATE DIPLOMA IN EDUCATION PROGRAMME
L.R. Gonsalkorale, S. Kugamoorthy, R. Mangaleswarasharma, K.D.R.L.J. Perera and S.S. Zarookdeen.----- 38

ENGINEERING

11. UTILISATION OF 'AS GENERATED' QUARRY DUST AS A FINE AGGREGATE IN CONCRETE
L.A. Joseph, N. Satheeshkumar and D.A.R. Dolage----- 45
12. MARITIME BOUNDARY GEO-FENCING WITH ENHANCED ACCURACY
A.M.I. Mhirani, A.W.C.K. Atugoda and D.N. Balasuriya----- 50
13. DESIGN OF AN IMPROVED ELEPHANT TRACKING SYSTEM
R.M.A. Priyadarshana and D.N. Balasuriya----- 55
14. MULTIPURPOSE PULSE OXIMETER: OXYGEN SATURATION, BODY TEMPERATURE AND HEART RATE COUNTING METER
T.D. Ariyaratne and W.D.S.S. Bandara----- 59
15. COMPARISON OF SOME DESIGN PROVISIONS OF BS 8110 AND EC2 CODES FOR THE DESIGN OF REINFORCED CONCRETE COLUMNS
T.C. Ekneligoda, T.M. Pallewatta, and L.S.S. Wijewardena----- 63
16. USE OF DUNE SAND AS AN ALTERNATIVE FINE AGGREGATE IN CONCRETE AND MORTAR
R. Sanjeevan, S. Kavitha, T.C. Ekneligoda, and D.A.R. Dolage----- 68
17. INVESTIGATION OF STRUCTURAL AND FOUNDATION FAILURES OF THE GODAKAWELA AGRARIAN SERVICES CENTRE BUILDING
K.M.L.K. Kandegedara and L.S.S. Wijewardena----- 73
18. CAPABILITY STUDY OF VERTICAL MOVEMENT AND EFFICIENT ATTACHMENT AND DETACHMENT MECHANISMS IN A WALL CLIMBING ROBOT
D.I.P.M. Wickramasinghe and C.J. Basnayakege----- 77

19. USE OF WASTE COCONUT SHELLS AS SUBSTITUTE FOR COARSE AGGREGATE IN LIGHT-WEIGHT CONCRETE MIXES
M.B.M. De Costa, D.D.T. Dasanayaka, M.N. Tantirimudalige, K.M.L.A. Udamulla and T.C. Ekneligoda ----- 81
20. ANALYSIS OF BLAST LOADING EFFECTS ON ELEMENTS OF REINFORCED CONCRETE BUILDINGS
D.D. Chamara, L.K.S. Priyadarshani and P.A.K. Karunananda ----- 85

ENVIRONMENTAL STUDIES

21. EFFECTS OF CONTAMINATED SOILS ON SURVIVAL, GROWTH AND REPRODUCTION OF *EISENIA ANDREI*
N.D.K. Saumyakumari and P.M.C.S. De Silva ----- 91
22. THE EFFECTIVENESS OF LOCAL PLANTS AS NATURAL COAGULANTS IN TREATING TURBID WATER IN SRI LANKA
M. Ravindara, S.R. Kumarapperuma, T.C. Ekneligoda and D.I. Fernando ----- 95
23. IMPACT OF CLIMATE CHANGE ON WATER RESOURCES IN CENTRAL HILLS OF SRI LANKA AND POSSIBLE ADAPTATION MEASURES
C.S. De Silva-----100
24. INTER-DECADAL VARIABILITY OF SEASONAL RAINFALL IN SRI LANKA WITHIN THE PERIOD 1951-2010
E.M.S. Ranasinghe, C.S. De Silva and R.U.K. Piyadasa ----- 104

HEALTH SCIENCES

25. INVOLVEMENT WITH AND ATTITUDES TOWARDS EXTRACURRICULAR ACTIVITIES AMONG MEDICAL STUDENTS AT THE UNIVERSITY OF SRI JAYEWARDENEPURA
R.M.G.P. Rathnayaka and S. Hulathduwa -----109
26. NURSES' KNOWLEDGE AND PRACTICES REGARDING THE NUTRITIONAL MANAGEMENT OF PATIENTS WITH NASO-GASTRIC TUBE FEEDING
D.I.U.K. Karannagoda, K.A.D.T. Leelarathne, K.B. Wimalasooriya, G.G.W.C. Wijesekara and A.V.P. Madavi-----113
27. THE NEED OF A COMMUNITY HEALTH NURSE: A COMMUNITY PERSPECTIVE
R.M.H. Randeni, S.S.K. Wanniachchi, S.H.M. Bisomenike, B. S. S. De Silva, and G.G.W.C. Wijesekara -----117

EFFECT OF MULCH ON SOIL PROPERTIES AND YIELD OF GROUNDNUT PLANTS EXPOSED TO TEMPERATURE STRESS

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INTRODUCTION

Groundnut (*Arachis hypogaea* L) is an important cash crop grown in the dry zone of Sri Lanka. Heat and/or drought-induced stresses are the major environmental factors that limit pod yields of groundnut. The optimum day/night temperature for vegetative and reproductive growth and development in groundnut ranges from 25/25° C (Wood, 1968) to 30/26 °C (Cox, 1979) and from 25/20 ° C (Wood, 1968) to 26/22 ° C (Cox, 1979), respectively. However, due to global warming, temperature in the globe is predicted to increase in the coming years and therefore it is imperative to find adaptation measures to cultivate groundnut as it plays a major role in the rural economy of Sri Lanka (De Silva et al, 2007). The main aim of this paper is to quantify the effects of high air temperature on nodulation and pod yield of groundnut and to identify the best mulch which contributed to reduce high temperature effects on groundnut.

METHODOLOGY

This study was conducted during the period October 2010 to April 2013 in temperature regulated poly tunnels constructed in the agricultural field of the Open University of Sri Lanka, Nawala, Nugegoda. One set of polytunnels was maintained at 32°C maximum temperature. Another set of polytunnels was maintained at 34°C. The temperature inside the polytunnels was set by a thermostat. Groundnut (Walawe) seeds were planted in pots filled with compost and reddish brown earth soil mixture (1 plant/ pot in 30 cm i.e. and 45 cm deep pots). Three types of mulches were used (coir dust, straw and saw dust) along with a control no mulch (15% of mulch). The plants were maintained without water stress by applying water to keep the soil moisture at field capacity level throughout the growing season, according to the findings of a previous study (Gunawardhana *et al*, 2011).

Data Collection and Analysis

The experimental design used was a Completely Randomized Design (CRD) with factorial treatment structure. Temperature and mulches were taken as factors. Analysis of covariance (ANCOVA) of the results was performed using General Linear Model procedure of Mini tab (Software Version 17). Standard error bars were developed using the maximum and minimum values of the mean values. The yield was collected at the end of 4 months after planting. The average of five replicates was taken as yield per plant. Air-dried plant weights and pod weight were measured using a digital balance. Physical and chemical parameters of the soil were estimated viz. pH by direct method (electronic pH meter), EC (measured using the conductivity meter), organic matter (determined using the ASTM D2974-Standard test method for organic matter), and moisture percentage and bulk density (estimated using the gravimetric method).

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RESULTS AND DISCUSSION

Effect of Mulch on Soil Properties

Soil pH

Average soil pH among the treatments ranged from 6.5 - 7.24 (Figure 1). Generally, plants mulched with saw dust and straw maintained significantly higher pH values than the others ($p < 0.05$). An important characteristic of coir dust is its low biodegradation. Coir dust consists of lignin, cellulose and hemicelluloses. About 90% is organic matter and the carbon nitrogen ratio is extremely high (>130) according to Van Mele (1997). The low pH of coir dust offers an extra protection against biodegradation, and many microorganisms do not survive once the pH is low. Slow biodegradation of organic mulches have been given more consideration, especially in tropical countries like Sri Lanka where fast mineralization of the humic substances and runoff with intensive rainfall are problems. Further, coir dust has a good cation exchange capacity (CEC) of 50 meq/100g dry matter (Van Mele, 1997) therefore; it improves the nutrient binding capacity of the low fertile soils. In addition, studies have shown that up to 70% of the nitrogen applied is often lost through leaching and application of a mixture of coir dust strongly reduces the nitrogen leaching by slowly releasing the nutrient (Vidhana Arachchi and Somasiri, 1997).

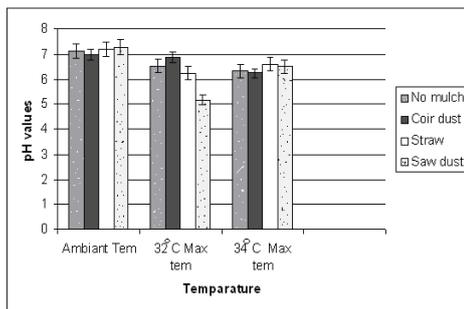


Figure 1: Effect of mulch on Soil pH

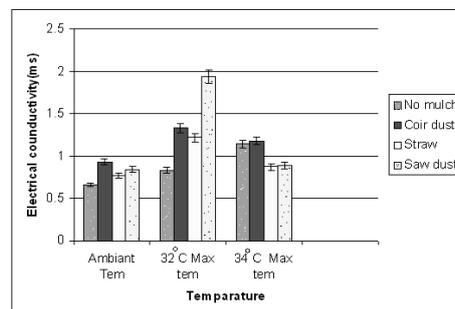


Figure 2: Effect of mulch on Soil EC.

Soil electrical conductivity (EC)

Average soil EC among the treatments ranged from 0.66 -2.22(ds/m) (Figure 2). The results showed a significant difference with temperature. There was a significant variation between coir and other mulches. It was found that a 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 (Li *et al.*, 1999). The highest EC was reported from the coir dust mulched treatment. EC proportionally increased with the moisture content. Straw mulching systems can conserve soil water and reduce temperature because they reduce soil disturbance and increase residue accumulation at the soil surface (Zhang *et al.*, 2009).

Organic matter content

Average soil organic matter content among the treatments ranged from 6.04-7.9% (Figure 3). (Initial stage organic matter content of the soil 4.5%) 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 prerequisite for sustainable and high production of crops according to Arafat (1994). 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 releasing of available nutrient

elements more to be absorbed by plant roots and this in turn increase dry matter content in the different peanut and lentil plant organs (Saber and Kabesh, 1990).

Moisture content

The average soil moisture among the treatments ranged from 19.08-23.8% (Figure 4). Plants mulched with coir, straw and saw showed higher moisture content. Manure and mulch can be used in soil and water conservation, since their appropriate use in soil treatment will reduce soil erosion. Fertile soil also produces higher yielding crops through this mulching treatment (Robert 1987). One of the most important characteristics of coir dust is the high water retention capacity. Coir dust can store up to 8 times its dry weight on water. By applying a 15 cm thick coir dust mulch layer around coconut seedlings in Sri Lanka, irrigation could be reduced by 40-55% during dry season. In a pineapple coconut intercrop during dry season the top soil layer had a moisture content of 49% under coir dust mulch compared to 10% under a sandy ridge of the same height. The water retention is not too strong as plant available water stored in coir dust mulch is about 50%, compared to 10% in organic sandy soils and 23% in organic loamy sand soils according to the recent studies carried out by students of the University of Gent and the College of Gent, Belgium at the Coconut Research Institute of Sri Lanka (Van Mele, 1997).

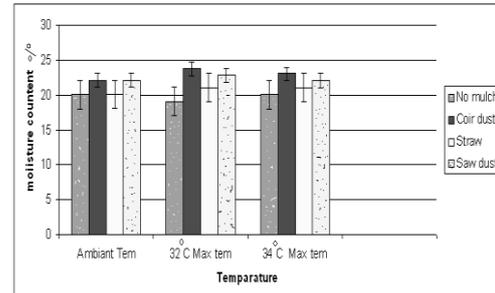
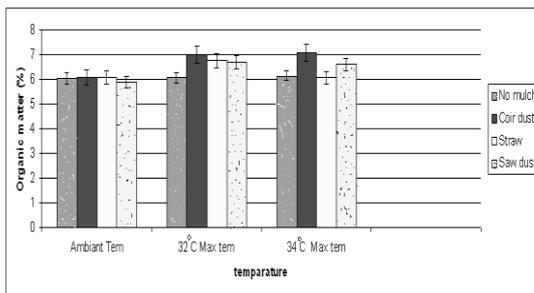


Figure 3: Effect of mulch on Organic matter moisture

Figure 4: Effect of mulch on soil content.

Yield of Groundnut

The results indicate the effect of individual mulches on yield (Figure 5). Pod yield reduced proportionately with the temperature. When the temperature increased pod yield reduced as the optimum air temperature for growth and development of groundnut is between 25⁰ C and 30⁰ C (Williams and Boote, 1995). It has been shown, for example, that the numbers of pegs and pods were reduced by 33% by exposure to a day temperature of 35⁰ C compared with 30⁰C (Ketring, 1984). The results of this study agree with the findings of Ketring (1984) as the number of pegs and pods were reduced in treatment exposed to 34⁰ C maximum temperature. The highest pod yield was obtained in coir dust mulch in all three temperature treatments. (p<0.05)

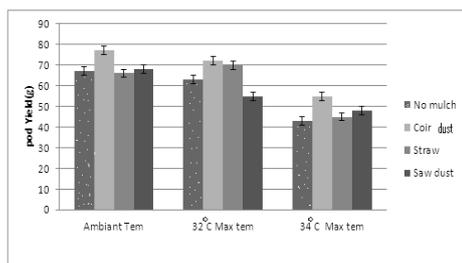


Figure 5: Effect of mulch on average pod yield

CONCLUSIONS

When considering the effect of mulch on soil properties, coir dust mulch treatment has the lowest pH compared to the other mulches which give protection against biodegradation. This is because most of the microorganisms do not survive in low pH. Coir dust mulch treated soil has the highest electrical conductivity and highest moisture content as electrical conductivity increases with increased moisture content. Coir dust mulch has very good water retention capacity, which will be advantageous in drought conditions. Furthermore, the study showed that the coir dust mulch has the highest organic matter content which is essential for plant nutrient availability, growth and yield. However, coir dust mulch has significantly higher yield even in all three temperature treatments. Coir dust mulch also performed well in plants exposed to heat stress compared to saw dust mulch. Even though there is temperature stress to plants due to global warming, by applying adequate water without water stress along with coir dust mulch, yield could be obtained without significant reduction. The findings of this study will help the farmers in dry zone to cope with temperature stress in coming years due to climate change.

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EGG QUALITY PARAMETERS OF FRIZZLE AND NAKED-NECK FRIZZLE CHICKEN GENOTYPES UNDER DIFFERENT DIVERSIFICATION SYSTEMS

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INTRODUCTION

The poultry industry in Sri Lanka is mainly oriented towards exotic germplasm. However, the productive performance of the exotic chicken is highly affected by various environmental factors, mainly temperature. Therefore, it is difficult to exploit the productive potential of exotic birds in high temperature regions at a low cost production system. Various management aspects can be introduced to reduce heat stress and to improve the productive level of exotic chickens. Introducing heat tolerance genes to the exotic germplasm is the permanent solution to resolve the constraint.

The heterozygous naked neck gene (*Nana*) causes a 20-30% reduction of feather coverage. This reduction in feather coverage facilitates better heat dissipation and improves thermoregulation, resulting in better relative heat tolerance in hot climates (Mahrous et al. 2008). In frizzle chickens, the rachises of all feathers are extremely re-curved, with barbs also being extremely curled. This causes a reduction in tropical heat stress by improving the birds' ability for convection, resulting in improved feed conversion and better performance (Merat 1990). Benedict *et al.* (1932) found a considerable increase in energy metabolism for frizzled birds, implying that they will respond differently, from normal feathered birds, to high temperatures.

In this context, a study was planned to analyze the egg quality traits of frizzle and naked-neck frizzle under different diversification systems. The results of the study will shed light on the type of diversification system that should be used to obtain good quality eggs from the frizzle and naked-neck frizzle genetic groups of chicken.

METHODOLOGY

The study was conducted in different locations in Batticaloa, Ampara and Trincomalee districts of Sri Lanka during the period from January 2013 to March 2014. A total of 150 poultry farms rearing both chicken types together were selected for this study. Equal numbers of crop-based, livestock-based and monoculture farms were considered in gathering data. For a crop-based farming system, the farms with biennial and annual crops were considered, and for livestock-based farming systems, farms with ruminant animals such as cattle, buffalo and goat were considered. From each farming system, a total of 100 eggs were randomly selected to gather information. Semi-intensively operated farms were selected for the study. The production parameters measured were egg weight, egg shape index, specific gravity, fertility, hatchability, albumen weight, yolk weight, yolk: albumen ratio, shell weight and shell thickness. Data of the three diversification systems of each chicken genetic group were subjected to an analysis of variance (ANOVA) using the General Linear Models (GLM) Procedure of the Statistical Analysis System (SAS 2004). Where significant differences were observed, treatment means were compared with the Duncan's Multiple Range Test. All statements of statistical differences were based on $p < 0.05$.

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RESULTS AND DISCUSSION

External quality traits of eggs

Significant differences were observed ($P>0.05$) in all the external quality traits of both genetic groups of chicken in all the diversification systems.

Table 1: External quality traits of the egg of frizzle and naked-neck frizzle chicken under different diversification systems (\pm Standard Error)

Traits	Frizzle			Naked-neck frizzle		
	Crop-based (n=200)	Livestock- based (n= 200)	Monoculture (n= 200)	Crop-based (n= 200)	Livestock- based (n= 200)	Monoculture (n= 200)
Mean egg weight (g)	47.33 \pm 1.64 ^c	44.23 \pm 1.27 ^b	41.39 \pm 1.45 ^a	52.64 \pm 2.01 ^f	47.01 \pm 1.32 ^q	43.62 \pm 1.11 ^p
Egg shape index (%)	73.44 \pm 1.27 ^c	71.12 \pm 1.02 ^b	69.98 \pm 1.72 ^a	75.21 \pm 1.21 ^f	73.04 \pm 1.73 ^q	70.96 \pm 1.25 ^p
Specific gravity	1.13 \pm 0.01 ^c	1.09 \pm 0.02 ^b	1.04 \pm 0.02 ^a	1.15 \pm 0.01 ^f	1.10 \pm 0.02 ^q	1.04 \pm 0.03 ^p
Fertility (%)	73.07 \pm 1.56 ^b	76.32 \pm 1.43 ^c	69.64 \pm 1.56 ^a	72.64 \pm 1.27 ^p	79.21 \pm 1.75 ^f	75.23 \pm 1.66 ^q
Hatchability (%)	80.46 \pm 1.34 ^b	75.64 \pm 1.04 ^a	82.55 \pm 3.78 ^c	90.62 \pm 4.01 ^f	79.38 \pm 3.76 ^p	86.34 \pm 2.72 ^q

*Means with the same letters across the rows for each chicken genetic group are not significantly different

a) Egg weight

The mean egg weight was significantly higher ($P<0.05$) in a crop-based diversification system while it is significantly lower ($P<0.05$) in a monoculture system for both genetic groups of chicken (Table 1). Under the crop-based farming system, the availability of diverse feed materials such as grains, seeds, green leaves, crop residues and insect pest are comparatively higher than in other farming systems. Therefore, the energy gain is high. Further, under the crop-based farming system, the energy loss is reduced as the shade is high.

b) Egg shape index

The egg shape index was significantly higher ($P<0.05$) in both genetic groups of chicken in the crop-based diversification system, while it was significantly lower ($P<0.05$) under the monoculture system for both genotypes (Table 1). Under the crop-based diversification system, exposure of birds to sunlight stimulates reproductive activity and starts egg production on time, and will reflect in egg size. In other diversification systems studied, it was observed that sheds and highly-shaded trees were there.

c) Specific gravity of egg

Specific gravity was significantly higher ($P<0.05$) in the crop-based farming system for both genetic groups of chicken (Table 1). The gravity was higher as the weight and volume are the determinants of specific gravity. Comparatively, the lowest value was recorded in both genetic groups of chicken in monoculture. The results indicated that specific gravity is directly proportional to egg weight. This was agreed with the reports made by Yeasmin and Howlider (1998), Nahar *et al.* (2007), Onagbesan *et al.* (2007).

d) Egg fertility

Egg fertility was significantly higher ($P<0.05$) in both genetic groups of chicken under the livestock-based diversification system, while it was lowest in the monoculture system (Table 1). Under the livestock-based diversification system, the availability of protein-based feeds such as feces, feed residues, etc are highly available. This might be the reason for higher fertility in that particular system. Further, under livestock intensification, laying facilities are high as the birds can find specific places for laying. Therefore, the physical forces to damage the egg and embryo will be reduced. However, under the monoculture and crop-based diversification systems, these facilities do not exist.

e) Egg hatchability

Hatchability was significantly differed ($P<0.05$) among different diversification systems for both genetic groups of chicken in all the diversification systems. The hatchability of eggs for both the chicken genetic groups of chicken was significantly higher ($P<0.05$) under the crop-based diversification system (Table 1).

Internal quality traits of egg

Significant differences were observed ($P<0.05$) in all the internal quality traits of both genetic groups of chicken in all the diversification systems.

Table 2: Internal quality traits of the eggs of frizzle and naked-neck frizzle chicken under different diversification systems (\pm Standard Error)

Traits	Frizzle			Naked-neck frizzle		
	Crop-based (n= 200)	Livestock- based (n= 200)	Monoculture (n= 200)	Crop-based (n= 200)	Livestock- based (n= 200)	Monoculture (n= 200)
Albumen weight (g)	26.34 \pm 1.23 ^c	23.11 \pm 1.04 ^b	20.25 \pm 1.21 ^a	27.55 \pm 1.76 ^r	26.38 \pm 1.54 ^q	22.62 \pm 1.56 ^p
Yolk weight (g)	16.42 \pm 0.94 ^c	13.12 \pm 1.12 ^b	10.76 \pm 1.01 ^a	18.64 \pm 1.32 ^r	15.37 \pm 1.33 ^q	10.64 \pm 1.02 ^p
Yolk:albumen	0.62 \pm 0.01 ^c	0.56 \pm 0.02 ^b	0.53 \pm 0.02 ^a	0.59 \pm 0.01 ^r	0.58 \pm 0.01 ^q	0.47 \pm 0.01 ^p
Egg shell weight (g)	4.57 \pm 0.13 ^a	8.00 \pm 0.11 ^b	10.38 \pm 0.15 ^c	6.45 \pm 0.21 ^q	5.26 \pm 0.19 ^p	10.36 \pm 0.78 ^r
Egg shell thickness (mm)	0.28 \pm 0.002 ^a	0.37 \pm 0.003 ^b	0.45 \pm 0.002 ^c	0.33 \pm 0.002 ^q	0.30 \pm 0.002 ^p	0.45 \pm 0.002 ^r

*Means with the same letters across the rows for each chicken genetic group are not significantly different

a) Albumen weight

In accordance with the results obtained (Table 2), albumen weights differed significantly ($P<0.05$) between different diversification systems, with the highest values being presented by both genetic groups of chicken under the crop-based diversification system. The correlation between total egg weight (Table 1) and albumen weight was strong and positive (Suk and Park 2001).

b) Yolk weight

The yolk weight of both genetic groups of chicken is significantly higher ($P<0.05$) in the crop-based diversification system (Table 2). Under the crop-based diversification system, the availability of diverse nutrition is higher than in other systems. In literature, a similar observation was reported by Fikry Amer (1972) and Parmar et al. (2006). The correlation between yolk weight and total egg weight (Table 1) was strong and positive (Offiong et al. 2006; Suk and Park 2001).

c) Yolk: albumen (Y:A) ratio

The calculated Y:A ratio was significantly highest ($P<0.05$) under the crop-based diversification system. However, in naked-neck frizzle chicken, it was significantly higher in both the crop- and livestock-based diversification systems (Table 2). Here, it is important to line out the great importance of yolk proportion in the egg processing industry as it is linked to higher dry matter content and to a higher content of essential fatty acids (Benabdeljelil and Merat 1995).

d) Egg shell weight and thickness

Egg shell weight and thickness were significantly higher ($P<0.05$) in the monoculture system for both chicken genetic groups. In most of the surveyed areas, chicken keepers provide

calcium as a supplement to their birds under monoculture. This might increase egg shell weight and the thickness of the eggs of the chicken.

CONCLUSION

The frizzle and naked-neck frizzle chicken perform well under the crop-based diversification system in terms of all the external and major internal quality traits. Therefore, the performance of these chicken genetic groups could be further improved under the crop-based diversification system with improved management practices and breeding programs.

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**IMPACT OF MULCHES ON PHYSIOLOGICAL PARAMETERS OF TOMATO
(*Solanum lycopersicum* - variety Thilina) AT DIFFERENT GROWTH STAGES
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. In particular, further reduction in existing limited water resources, combined with an increase in temperature, may result in a higher impact on agricultural crops.

Annual mean air temperature anomalies have shown significant increasing trends in Sri Lanka. The rate of increase of mean air temperature for the 1961-1990 period is in the order of 0.016°C per year. Annual mean maximum air temperatures have shown increasing trends in almost all stations, with the maximum rate of increase about 0.021°C per year in Puttalam. Night-time annual mean minimum air temperatures have also shown increasing trends with higher gradients. The maximum rate of increase of night-time annual mean minimum air temperature is reported to be about 0.02°C per year in Nuwara-Eliya.

Environmental stress is the primary cause of crop losses worldwide, which reduces average yields for most major crops by more than 50% (Boyer 1982). The tropical vegetable production environment is a mixture of conditions that varies with season and region. Climatic changes influence the severity of environmental stress imposed on vegetable crops. Moreover, increasing temperatures, reduced irrigation water availability, flooding, and salinity are major limiting factors in sustaining and increasing vegetable productivity. Tomatoes are very sensitive to water deficits during and immediately after transplanting, at flowering and during fruit development (Nuruddin, 2001). Kirnak et al. (2001) have found that water stress results in significant decreases in chlorophyll content, electrolyte leakage, leaf relative water content and vegetative growth.

METHODOLOGY

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

Nursery management was initiated and tomato seedlings were transplanted into individual plastic pots (1 plant/ pot in 30 cm diameter and 45 cm deep pots). The pots were filled with compost and sandy loam soil mixture, and the two mulching treatments of coir dust and saw dust with control treatment (no mulch) were arranged in a completely randomized design.

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Two mulches were added until the surface of the compacted soil was within 1.5 cm of the brim. The tomato plants were grown under 3 different conditions, as indicated in Table 1.

The experiment consisted of two factor factorial design was carried out, which included three replicates. Pots were arranged according to a complete randomized design (CRD). Water stress and mulches were taken as treatment factors. The physiological parameters of the tomato (Leaf Relative Water Content (LRWC) and Leaf chlorophyll content (LCC)) were investigated during the Vegetative stage (end of transplanting stage to flowering), the Reproductive growth stage (until first full size mature green fruit) and the Ripening stage (color changing of fruit). An analysis of variance (ANOVA) of the result was performed using the statistical program Minitab (version 14, Minitab Inc.) at $P < 0.05$.

Table 1. Three different environmental conditions imposed

<i>Condition No</i>	<i>Environmental conditions</i>
Condition 1 – Poly tunnel 1	<u>Ambient temperature 32 °C</u> (i). Providing adequate water to reach the substratum in mulched pots. (ii). Providing water to fill only up to 50% of the substratum in mulched pots.
Condition 2 – Poly tunnel 2	<u>Ambient temperature 34 °C</u> (i). Providing adequate water to reach the substratum in mulched pots. (ii). Providing water to fill only up to 50% of the substratum in mulched pots.
Condition 3 – Open space	<u>Ambient temperature (AT⁰C)</u> (i). Providing adequate water to reach the substratum in mulched pots. (ii). Providing water to fill only up to 50% of the substratum in mulched pots.

RESULTS AND DISCUSSION

The Leaf Relative Water Content (LRWC) at different growth stages

The LRWC was measured at three different growth stages. The LRWC varied significantly due to different mulches and water stress at AT⁰C in the vegetative growth stage. Mulching treatments demonstrated superior performance related to the LRWC than the control without mulch, at three different temperatures. Saw dust mulch had a positive effect from water stress conditions at 34⁰C temperature. The three different growth stages showed positive effects with mulching conditions at temperature variations and water stress conditions.

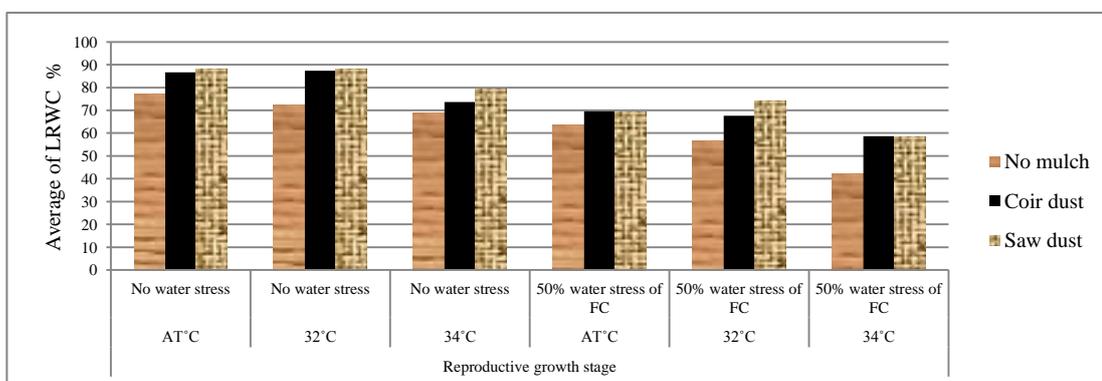


Figure 01. The effect of mulch and water stress on LRWC in the Reproductive stage

The lowest LRWC was reported in the without mulch crop at 34 °C in the reproductive stage (Figure.01). However, the LRWC demonstrated decreasing function at 32°C and 34 °C in the Ripening stage (Figure 02), but the saw dust and coir mulch treatments showed good LRWC conditions in higher temperatures. Therefore, mulching helps to maintain the LRWC, and consequently increases the yield of tomato.

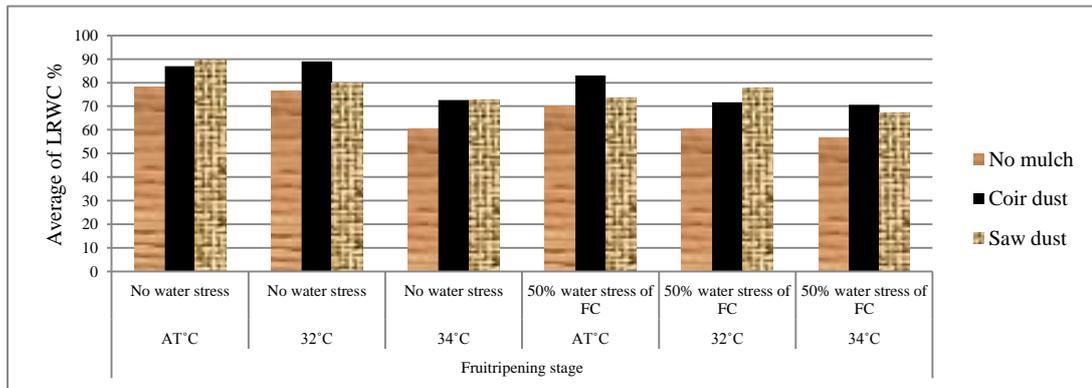


Figure 02. The effect of mulch and water stress on average LRWC at the Ripening stage

The Leaf chlorophyll content (LCC) at different growth stages

The water stress resulted in significant decreases in LCC. There are reports showing the decrease in chlorophyll under drought stress (Kulshreshta et al., 1987). The effect of mulch and water stress on the LCC in the vegetative stage demonstrated that the no water stress plants have more LCC than water stressed plants in all three temperature conditions.

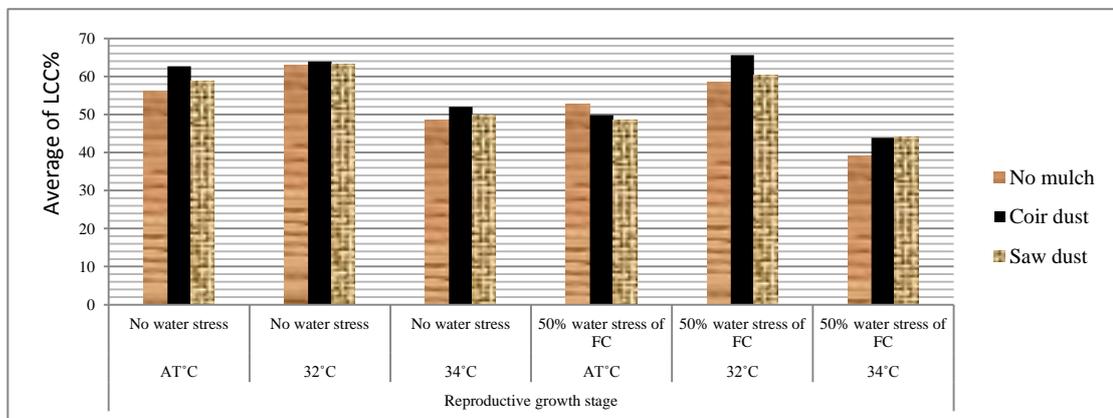


Figure 03. The effect of mulch and water stress on average LCC at the Reproductive stage

The coir and saw dust mulched plants at 32°C temperature showed significantly higher LCC even at the water stressed condition of the Reproductive stage compared with that of the no mulch treatments (Figure 03). However, at the Ripening stage, saw dust mulched plants showed higher LCC and also a higher yield (Figure 04). Kirnak et al., 2001 demonstrated that the total LCC in high water stress was reduced by 55% compared to the control which agrees with present results.

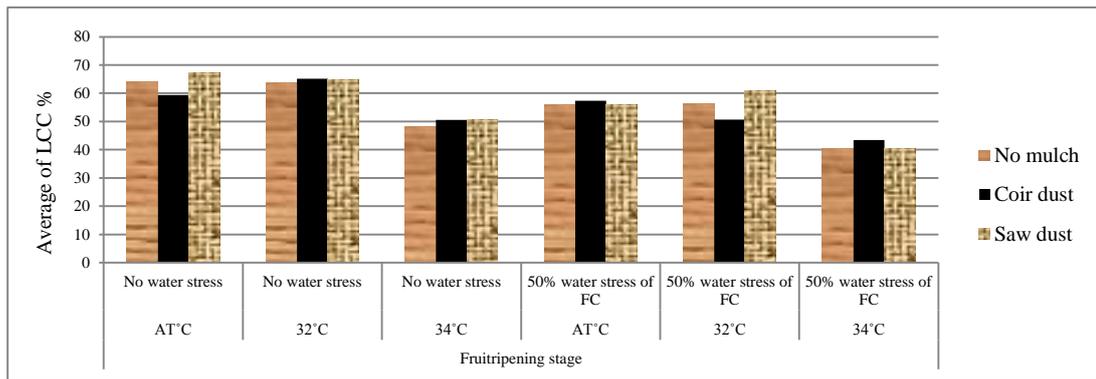


Figure 04. The effect of mulch and water stress on average LCC at the Ripening stage

CONCLUSION

According to the results, there is a significant effect from mulch at the different growth stages of Tomato plants that are exposed to water and temperature stresses. The water stress resulted in significant decreases in LCC and the LRWC. Water and temperature stress, in combination, had severe negative effects during the growth stages as compared with the mulched treatments. Results showed a significant effect on LCC at 32°C and 34°C during the Reproductive and Ripening stages ($p < 0.05$). The two way interaction (mulch*water stress) showed a significant effect on LCC ($p < 0.05$). LRWC showed a significant effect of 34°C in the Reproductive stage. Mulched plants showed a higher water and LCC compared with the no mulch treatment under water and temperature stress, and therefore, the yield of tomato was improved. The findings of this study will help farmers in the dry zone to maintain their tomato cultivation as required. Agronomic management practices, such as mulching for suitable crop growth at the different growth stages, could be adopted to adjust to the climatic changes in Sri Lanka.

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ECOTOXICOLOGICAL ASSESSMENT OF SOME SELECTED WEEDICIDE FORMULATIONS ON *Eisenia Andrei* UNDER TROPICAL CONDITIONS

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INTRODUCTION

Intensified agriculture, to meet demands for high crop production, has led to a long-term accumulation of agrochemicals in soil. The continuous dependence on these agrochemicals has brought great concern of potential hazards on soil fauna and soil functions. Continuous application, poor management practices and direct application to the soil surface may lead to the retention of weedicides in the soil ecosystem that can cause harmful effects on soil organisms. For a proper assessment of pesticide risks to soil ecosystems, data on their toxicity to soil organisms is needed (De Silva, 2009). Earthworms are considered to be good model organisms to evaluate soil contamination due to their role in decomposition, nutrient cycling and soil structuring processes. Earthworms have shown to be susceptible to pesticides. Over the last 10 years, some data on the toxicity of pesticides to earthworms has been obtained and it has been shown that results of laboratory toxicity tests may provide a reasonable prediction of field effects. Satunil60 (Thiobencarb+Propanil) and Supereon (Propanil) are among the commonly used weedicides that is used in Sri Lanka. No studies have been performed with soil organisms using these chemicals and the toxicity of these chemicals on beneficial soil organisms such as earthworms is unknown. Therefore, we study the toxicity of these weedicides under tropical conditions as an initial risk assessment.

METHODOLOGY

Satunil60 (Thiobencarb+Propanil) and Supereon (Propanil) samples were obtained from the local market. Adult earthworms (*Eisenia andrei*, 450-600 mg) from synchronized cultures in the laboratory were selected and acclimatized in natural soil collected from the upper most soil layer at a site near Dickwella in Matara, and sieved in the laboratory to be used as a homogeneous substrate. This soil had a pH of approx. 6.5, 3.7% organic matter and 5.6% clay. In addition, OECD artificial soil was used (OECD, 1984) as a test substrate. Toxicity tests were performed according to the ISO guideline 11268-2 (1998) and OECD (1984). In the tests, earthworms were exposed to a series of nominal concentrations (1, 3, 10, 30, 100, 300 and 900 mg a.i /kg dry soil) of the test chemicals, homogeneously mixed in with the test soil. The control soil was moistened only with chlorine-free water. Mortality after 28 days and behavioral effects were observed as the end points. Soil was returned into the test containers for another 4 weeks to allow cocoons to hatch. At the end of the 8-week test period, the number of juveniles produced was determined. The LC 50 and 95% confidence limits were calculated by the Trimmed Spearman Kärber method (Hamilton et al, 1977). The model for a logistic response was used for the calculation of EC₅₀ and 95% confidence limits. The Lowest Observed Effect Concentrations (LOEC) and the No Observed Effect Concentrations (NOEC) was determined using ANOVA and Dunnett's test by SPSS version 16.0.

RESULTS AND DISCUSSION

Acute toxicity of the two formulations is given in Table 1. The highest toxicity was recorded with Satunil60, which was a combination of the active ingredients of Thiobencarb and Propanil, than with Supereon, which contains only Propanil. Hypersensitivity, secretion of mucus and a loss of mobility of earthworms were observed even in lower concentrations. No observed recovery of behavioral effects suggests that any recovery after the exposure was not

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possible. The toxicity of both formulations in the natural soil was higher than in the OECD artificial soil. Natural soil contained lower organic matter content compared with OECD soil. Generally, organic matter tends to retain contaminants resulting in lower bioavailability, and is therefore one of the main reasons behind lower toxicity of these formulations in OECD soil.

The EC50 values for earthworm reproduction are also given in Table 1. The lowest EC50 value for reproduction compared with the controls was recorded with Supereon in natural soil, which indicates that the used formulation was highly toxic to earthworms. This is followed by recording in natural soil, Satunil60 in OECD soil and Supereon in OECD soil, respectively. It was also noted that chronic toxicity of these two formulations was higher in natural soil than OECD soil. This could be linked with the presence of higher organic matter that resulted in lower bio-availability. In general terms, all recorded LC50 values and EC50 values were less than 50 mg a.i/kg dry soil except two occasions in OECD soil, which indicated high toxicity of these two formulations on tested earthworm species.

CONCLUSIONS / RECOMMENDATIONS

Satunil60 (Thiobencarb + Propanil) can be considered as the most toxic and Propanil has recorded the least toxic of the two tested weedicides. Nevertheless, the low LC₅₀ values of both weedicide formulations indicate high toxicity on earthworms. It also revealed that the toxicity of these formulations in natural soil is always higher than in OECD soil, and hence their application under realistic field conditions should be done with caution. Further, studies with pure compounds and field studies with the above formulations will also be beneficial in further risk assessment of weedicides.

Table 1: Toxicity of formulated products of Satunil60 and Supereon to the earthworm *Eisenia andrei* in natural soil and OECD soil. The LC₅₀ values (28 days) for the effects on survival and EC₅₀ values for the effects on reproduction are given with corresponding 95% CI (in parenthesis). All values are expressed in mg a.i kg⁻¹ dry soil

Formulation	Soil type	LC50	EC50 (Reproduction)
Satunil60 (Thiobencarb+Propanil)	Natural Soil	17.32 (nd)	12.3 (8.37-16.22)
	OECD Soil	51.71 (47.76-55.98)	16.92 (9.48-24.35)
Supereon (Propanil)	Natural Soil	44.78 (38.99-51.42)	3.06 (2.38-3.74)
	OECD Soil	191.84 (173.52-210.52)	121.45 (40.15-202.80)

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**SCHOOL BASED INSTRUCTIONAL SUPERVISION PROCESS: ISSUES
ENCOUNTERED
BY SUPERVISORS AND TEACHERS.**

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INTRODUCTION

Schools in Sri Lanka face significant problems related to the twin concepts of poor classroom instruction and low student achievement. As an example, when we considered student achievement in our national examinations, it provides us important proof. As mentioned by the Examinations Department of Sri Lanka a considerably higher number of students do not reach the expected mastery level at the GCE O/L examination. In 2011, a higher percentage of students had failed even compulsory subjects like Mathematics (47.29%) Science (40.21%), Sinhala (15.17%) and English (57.23%) in the GCE (O/L) examination. Therefore, in order to ensure the effectiveness of the classroom teaching-learning process and the quality of education in our general education system more attention should be paid to these aspects.

In this particular context, instructional supervision process has become an integral component and process in the functioning of every school (Sergiovanni & Starratt, 1998). Various authors have defined instructional supervision in different ways. Glickman (1992) views instructional supervision as the actions that enable teachers to improve the quality instructions for students and as an act that improves relationships and meets both personal and organizational needs. Sergiovanni and Starratt (2002:6) describe instructional supervision as the opportunities provided for teachers to develop their capacities to contribute for students' academic success. Therefore, instructional supervision process is important because, the merits of a proper instructional supervision process could influence the improvement of the pupils' performance and ultimately, the teacher's professional development.

According to Glanz (2010), school teachers have a common challenge in providing high quality education to their students. Those challenges can be linked to instructional supervision, teaching behavior and low learner performance of students. Therefore, it has been identified that the primary purpose of instructional supervision process is to support and sustain all teachers in their goal of professional development, which ultimately results in quality instruction. Such growth and development rely on a system that is built on trust and is supportive of teachers' efforts to be more effective in their classrooms (Beach & Reinhartz, 2000).

Contemporary educational research studies have identified instructional supervision as completion of paper work and a fault finding mechanism rather than a process which will improve teacher performances. According to that, many researchers have identified various issues encountered by those who are engaged in the instructional supervision process. Accordingly, this study focused on the issues encountered by supervisors and teachers in the instructional supervision process of the schools.

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

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1. What are the problems faced by principals in conducting the instructional supervision process of the school?
2. What are the problems faced by other supervisors who take part in the instructional supervision process of the school?
3. What are the problems faced by teachers in line with the instructional supervision process of the school?

METHODOLOGY

The survey research design and the descriptive research approach were selected to carry out this study. Both qualitative and quantitative techniques have been used for data collection which included questionnaires and interviews. Simple statistical methods were used for data analysis. The school population of this study includes all (46) the 1AB, 1C, Type ii & Type iii schools in the Dehiattakandiya Educational Zone of the 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 section heads, 24 subject heads and 120 teachers.

RESULTS AND DISCUSSION

1. The problems faced by Principals in conducting the instructional supervision process of the school.

Table 1: Principals' responses on the problems

No	Statements	Number Respon- ded	Percenta- -ge (%)	Number not Responded	Percen tage (%)	Total	
						Num- -ber	Percen- -tage (%)
1	Lack of experienced and competent supervisors in the school	08	80.0	02	20.0	10	100.0
2	Negative attitudes and unhappiness concerning supervision of teachers	05	50.0	05	50.0	10	100.0
3	Lack of pedagogical knowledge concerning instructional supervision.	04	40.0	06	60.0	10	100.0
4	Lack of formal training opportunities concerning instructional supervision.	04	40.0	06	60.0	10	100.0
5	Time allocation problem for instructional supervision process.	06	60.0	04	40.0	10	100.0
6	Obstacles to establishing of sound supervisory culture in the school	03	30.0	07	70.0	10	100.0

According to Table 1, the majority (80%) of principals faced the problem of lack of experienced and competent supervisors in the school as a highly important issue regarding the instructional supervision process. On the other hand, during the interviews they pointed out that due to lack of experienced senior teachers they were unable to establish an effective supervisory team in the school. It has been identified that nearly 60% of principals had difficulty in allocating time for instructional supervision process as a second important issue. Table 1, further revealed that negative attitudes and unhappiness of teachers concerning instructional supervision was a another important issue faced by principals (50%).

2. The problems faced by other supervisors who take part in the instructional supervision process of the school.

According to the Table 2, nearly 46.1 % of Vice Principals and 30.4% of section heads faced the problem of other administrative workloads, lack of formal training for supervisors, negative attitudes concerning supervision of teachers and absenteeism of teachers during supervision. Nearly 47.0 % of subject heads had faced problems such as absence of teachers at the point of supervision, lack of resources (learning materials, classroom facility, etc....), not given sufficient time for the instructional supervision process (40.7%) and lack of pedagogical knowledge on instructional supervision (41.2%) in line with the instructional supervision process.

Table 2: Supervisors' responses about issues faced in the instructional supervision process (Vice Principals, Section Heads & Subject Heads)

Statement	Vice Principals		Section Heads		Subject Heads		Total	
	Number	%	Number	%	Number	%	Number	%
1. Not having sufficient time for the Instructional Supervision process.	04	30.8	06	26.1	08	40.7	18	34.0
2. Other administrative workloads.	06	46.1	07	30.4	05	29.4	18	34.0
3. Lack of pedagogical knowledge concerning instructional supervision.	04	30.8	06	26.1	07	41.2	17	32.0
4. Lack of formal training for supervisors	06	46.1	07	30.4	06	35.3	19	35.8
5. Negative attitudes concerning supervision of teachers.	06	46.1	07	30.4	06	35.3	19	35.8
6. Not allocating supervision responsibilities in writing.	03	23.1	03	13.0	06	35.3	12	22.6
7. Absence of teachers on the date of supervision.	06	46.1	10	43.4	08	47.0	24	45.2
8. Barriers for our own teaching-learning process.	0	0.0	05	21.7	07	41.1	12	22.6
9. Lack of resources (learning materials, classroom facility, etc....)	02	15.4	06	26.1	08	47.0	16	30.1
Not responded	05	38.5	05	21.7	07	41.2	17	32.0

- 3 . The problems faced by teachers in line with the instructional supervision process of the school (Table 3 based on responses given by teachers for open ended questions of the teachers' questionnaire)

Table 3: Teachers' responses on issues encountered in the instructional supervision process

Statement	Teachers Responses	
	Number	%
Not appointing subject specialists for instructional supervision process.	67/120	55.8
Lack of pedagogical knowledge of supervisors concerning instructional supervision.	73/120	60.8
Supervision process had not been planned, implemented and supervised properly.	57/120	47.5
Not maintaining supervisory work plan.	37/120	30.8
Not maintaining supervision reports systematically.	39/120	32.5
Some supervisors are the authoritarian type and unable to maintain a friendly relationship with teachers when supervising teaching- learning process	29/120	24.1

According to Table 3, nearly 61. % of teachers faced problems relating to lack of pedagogical knowledge of supervisor and nearly 55.8. % of teachers faced problems with the fact of not appointing subject specialists for instructional supervision process.

CONCLUSIONS/RECOMMENDATIONS

The effectiveness of the class room teaching-learning process depends on many factors. In order to ensure an optimum teaching-learning environment in the classroom, the instructional supervision process should be implemented regularly and systematically. In this context, it is very important to identify issues encountered by supervisors and teachers in line with the school based instructional supervision process. It has been identified that instructional supervision process is a good mechanism to up-grade the performance of teaching-learning process and promote teachers' professional development. The study revealed that the majority of principals faced lack of experienced and competent supervisors in the school, time allocation problems for the supervision process and negative attitudes and unhappiness of teachers concerning supervision as problems in the instructional supervision process.

It can be concluded that, the majority of other supervisors (vice principals, section heads and subject heads) have major issues, the administrative workloads, deficiencies in formal training of supervisors, negative attitudes concerning supervision of teachers, absenteeism of teachers and lack of pedagogical knowledge concerning instructional supervision, with regard to the instructional supervision process. The fact that the planning, implementing and monitoring stages of the supervision process were not carried out according to schedule also became a major issue for the teachers.

Accordingly, some recommendations could be made as follows:

1. Principals should give priority to improve instructional supervision process and instructional supervision should be carried out continuously in the school.
2. All the supervisors should use effective methods of instructional supervision and be committed to the long term process of staff development.
3. Supervisors' administrative workload should be reduced or decentralized to provide sufficient time to participate effectively in their instructional supervisory roles.
4. Supervisors should have high professional qualifications and a superior knowledge about curriculum and instructional supervision so as to be better role models and to provide expert leadership in all areas of the school programme to their teachers and pupils.

5. All the supervisory staff must be constantly refreshed with quality & appropriate supervision training.
6. All supervisors require conceptual skills in supervision in its broadest sense in order to ensure that they fully understand what their roles and tasks as supervisors of schools are. to promote effective instructional supervision, in making the supervisory process more effective.
7. All the supervisory staff should develop positive attitudes towards supervision of teachers.
8. All the supervisory staff should maintain and use instructional supervision reports to improve the teaching-learning process and professional development of teachers.
9. Supervisors should create a conducive and facilitating environment for instructional supervision process in the school.
10. The government should provide more funds to schools to expand physical facilities and human resources which will in turn improve supervision.

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PERCEPTIONS OF DIFFERENT STAKEHOLDERS ON READINESS OF CHILDREN ENTERING GRADE ONE

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INTRODUCTION

School entry is a significant milestone in a child's life, as well as in the life of his/her parents. According to Entwisle and Alexander (1998), the commencement of formal schooling is presented as a critical period in child development. During this critical period of transition, children's external worlds as well as the internal worlds undergo rapid changes. On the other hand, the high level of structure that characterizes school and classroom context demands more from children of their behavior, social and emotional competence, cognitive development, physical development and well-being and understanding and coping with school environment itself (Margetts, 2000b). Inability to create a balance between the two environments, namely home and school, would also lead to "tensions between change and stability and between adjusting to new challenges and preserving new patterns" (Rimm-Kaufman and Pianta, 2001: 505) thereby accelerating the development of mental health problems (Commonwealth Health and Aged Care, 2000). Further, misconceptions prevalent among key stakeholders regarding the growth and development of these children would lead to deficiencies in the quality of stimulation, support and nurture which may have long lasting effects in their lives. Therefore, assisting children to manage this potentially challenging transition period and make a positive start to school can help in maintaining and fostering a positive sense of help (Entwisle and Alexander, 1998) and thereby supporting their well-being. Preschool teachers and primary teachers have a major role to play in this regard. As such, a comprehensive study has been carried out by the Ministry of Education to develop a systematic process to assess school readiness of children entering grade one. The present paper analyses the perceptions of parents, pre-school teachers and primary teachers on school readiness of children entering grade one and the possible implications of their perceptions on the development and learning of those children.

METHODOLOGY

In line with the survey research design, the sample of the study included 125 children (S=71, T= 54) who entered grade one classes and their parents (120), 74 (S=44, T=30) grade one teachers, and 20 pre-school teachers. Grade one teachers had been conducting the "identification of the child programme" with newly entered children by the time that this study was carried out. Application of multi-methods such as observations on the performance of grade one children, focus group discussions with the parents and pre-school teachers and a questionnaire for grade one teachers permitted integrating both quantitative and qualitative methods for analyzing data in this study.

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RESULTS AND DISCUSSION

The observation schedule used for collecting data on school readiness of children entering grade one was prepared by amalgamating the competencies listed by the National Institute of Education in their manual on 'Identification of the child' and some items were selected from school readiness tests identified through the literature review. Data were recorded using a five point scale ranged from 'excellent' (5) to 'need more support' (1). The analysis (Table 1) revealed that at the school entry, the competencies (6) related to social and emotional development obtained the highest mean value (3.76) in comparison to other four groups of competencies in the selected group of children. Within the group, "willingly participate in singing and dancing" was received the highest mean value (3.98) and the lowest mean value was obtained by "be able to wait to get ones turn". The competencies (5) related to language development had shown the lowest mean value (3.45) and the competencies titled as "be able to engage in work attentively" and "be able to listen, understand and act accordingly" in this category received the lowest mean values (3.34 and 3.39 respectively) out of all 35 competencies which would provide the foundation for their cognitive development. The competencies related to physical health and well-being, cognitive development and approaches to learning were shown modest mean values (3.68, 3.68, and 3.65). It could be further noted that all the competencies of children entering grade one were above the average though only a few children had reached the satisfactory level (4.00) or exceptional level (5.00) at school entry.

Table 1: School readiness of children entering grade one

Category	Overall mean
Physical health and well-being (10 competencies)	3.68
Social and emotional development (10 competencies)	3.76
Approaches to learning (5 competencies)	3.68
Language development (6 competencies)	3.45
Cognitive development (4 competencies)	3.65

Having analyzed the data obtained through focus group discussions, it could be revealed that there was a noticeable difference between pre-school teachers who run their own pre-schools (14 in the sample but 60% in the whole country according to a MoE report, 2013 and who are being employed by an organization (Divisional Offices or religious organizations: 6) in their perceptions on children entering grade one. The first category preferred teaching to student activities and emphasized competencies related to reading, writing, numbers and English as the main competencies to be acquired by children entering grade one. They justified their opinion by highlighting reasons such as parents' pressure, sustainability of their preschool, competition with other pre-schools and demands of grade one teachers. It was shocking to find that some had been conducting tests to assess the performance of preschoolers which is not even encouraged till grade three in the school system. Some claimed that the flourishing start they had provided in their pre-schools led children to achieve success in grade 5 scholarship examination. It was surprising to find that a reasonable number of pre-school teachers did not have a clear idea about the expectations of schools on children entering grade one. The majority of pre-school teachers in the second category were knowledgeable about the grade one syllabus and they knew to link competencies related to pre-reading and pre-writing, gross and fine motor development and social development to 'school readiness'.

The majority of parents tend to focus on reading, writing, numerical skills and the competency in English as essential skills that should be acquired by their children at school entry. They want their children to be more competitive, outstanding, obedient and less troublesome in classroom activities. It was surprising to find that some parents preferred indoor activities; desk work and individual tasks where as the recommended strategies linked

with outdoor activities, play and group tasks that facilitate the holistic development of children. For them, pre-school is another formal setup that can provide a strong backing for their children's education. However, such attitude would further limit the joy and happiness of their children only to first two-to-three years of their life.

Grade one teachers emphasized the importance of obtaining pre-school education and our observations also confirmed that about 95% of children in the relevant age group are going to a pre-school. Table 2 (No such children =37.8%) also confirms this trend which should be considered as a very positive development in our education system. Further, as illustrated in Table 2, grade one teachers find those children as very active (31.1%), more skillful (24.3%) and more experienced (12.2%). On the contrary, they reported that non-preschoolers were average (13.5%), less socialized (12.2%) and very difficult to detach from their parents (9.4%), when compared with those who attended a pre-school. Only 9.4% of teachers felt that there were no outstanding differences between the two categories of children.

Table 2: Prominent characteristics of preschoolers and non-preschoolers

Preschoolers	f	%	Non preschoolers	f	%
Very active	23	31.1	Average in every aspect	10	13.5
More skillful	18	24.3	Less socialized/afraid of others	09	12.2
More experienced	09	12.2	No difference	07	9.4
Develop friendly relationship	07	9.4	Difficult to detach them from parents	07	9.4
Very enthusiastic	05	6.7	Not very forward	05	6.7
Forward and look for challenges	05	6.7	Expect teacher's help	04	5.4
Adjust well	03	4.1	No such children in grade one	28	37.8
No response	04	5.4	No response	04	5.4
Total	74	100	Total	74	100

When inquired about the problems they face with newly entered grade one children, they had given prominence to the following:

- The majority of children entering grade one do not possess basic life skills such as toileting and eating alone; fine motor skills such as holding and using pastels, pencils and scissors in the correct manner; working attentively for some time and completing a task till the end; social skills such as work in groups, caring for others, sharing with others, listening to others etc.
- Attempts made by inexperienced and untrained teachers to teach reading, writing and numerical skills for preschoolers have almost doubled their work. Supporting children to unlearn wrong skills is more difficult than supporting them to learn correct skills.
- Children in grade one feel annoyed and frustrated by repeating the same lessons they have learned at pre-schools (as they pointed out, grade one and even grade two syllabuses are taught at pre-schools) which might lead to develop troublesome behavior during early stages in their lives.
- Even though the procedures such as loading children with homework and conducting formal tests in some pre-schools would increase parents' attraction, they might obstruct the natural development of children.

The above situation clearly indicates that there is a mismatch between the expectations of pre-schools and primary schools about the competencies to be acquired by the children at school entry. Therefore, there is a need for developing a suitable mechanism to assess competencies of children at school entry and a feedback process to make all stakeholders accountable for the development of children.

CONCLUSIONS

On the whole, there is a positive move towards pre-school education in the country though it is imperative that the activities of the pre-schools should be streamlined towards the right direction. At school entry, the majority of children show a moderate performance in the required competencies which need to be further improved. However, misconceptions and contradictions among different stakeholders have led to a big controversy which has affected adversely on the holistic development of children passing through the early childhood years. Thus, all stakeholders should work collaboratively to provide a more conducive and favorable environment for our children in order to provide a positive start for their life at school.. Parents and pre-school teachers should focus more on the development of basic life skills of children in order to make them ready for the school. Finally, this study stresses the need for having a mechanism to assess competencies of children entering grade one which will provide an insight for grade one teachers as well as pre-school teachers to design and implement the teaching-learning processes to suit the characteristics of children.

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THE NEED FOR PLANNING SECONDARY EDUCATION TO DEVELOP VOCATIONAL-ORIENTED COMPETENCIES TO MEET THE NEEDS OF THE WORLD OF WORK

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INTRODUCTION

Education and development are inter-related. The reason for this inter-relationship is that development of human resources contributes to the development of a country. Kularathna (1982) stressed that there are no greater inputs to the society than investment in education. Giddens (2008) pointed out that the current world of work needs multi skilled people. But Haralambos et al (2000) argue that more people gain their skills out of the school rather than when they are in school. According to those views, present secondary education system must be changed. Secondary education should be more oriented to the world of work. Jayaweera (2004) pointed out that there were attempts to introduce various reforms to secondary education for the development of vocational oriented competencies which were not successful. One reason would be that many Sri Lankan people believed practical oriented jobs as low grade jobs. Education must prepare students to the future world of work. According to Hughes and Krochler (2005) secondary education should focus on developing vocational oriented competencies.

The present study focused on the identification of (1) perceptions of students, teachers and parents regarding current secondary education, (2) vocational oriented competencies expected by employers from potential employees, (3) the relationship between the secondary education curriculum and the world of work, (4) strategies for developing vocational oriented competencies in students so as to equip them for the world of work of the future and (5) it makes recommendations to gear secondary education to the world of work.

METHODOLOGY

This study used the mixed method approach to conduct the research. To identify perceptions of different stakeholders on secondary education, survey method was used. In addition, to identify the relationship between the secondary education curriculum and the world of work content analysis method was used. A sample representative of 1AB and 1C schools in Kandy district was selected for the survey. The study was conducted in 20 schools selected from the above district. In the selection of schools apart from school type, attention was also paid to the location of schools - urban, rural and estate and the medium of instruction, Sinhala or Tamil.

From those schools, 500 students, 200 parents and 200 teachers were selected according to the random sampling method. In addition, 60 employers and 50 key persons selected according to the purposive sampling method were included in the sample. For collection of data, questionnaires and interview schedules were used as instruments. In addition the study used a check list to collect data about the relationship between secondary education and the world of work. The responses of teachers, students and parents, who participated in the above survey, were triangulated.

In order to examine the relationship between the secondary education curriculum and the world of work, a content analysis of Teacher Instructional Manuals of 19 subjects in Grades

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10-11 and Teacher Instructional Manuals on Life Competencies and Citizenship Education and Practical and Technical Skills for grades 6 to 9 was carried out.

Data analysis was carried out using both qualitative and quantitative methods. For quantitative analysis percentages and the Chi-squares and level of significance were calculated using the SPSS computer software. In qualitative analysis the content analysis technique was used.

RESULTS AND DISCUSSION

According to the results of data analysis it was evident that the perceptions regarding secondary education were positive. Further, it was possible to conclude that greater importance should be given to basket subjects. The interviewees said education must provide more opportunities for development of vocational oriented competencies in students. Content analysis revealed that use of practical methods in teaching, development and evaluation of vocational oriented competencies in school, development of positive societal attitudes regarding vocations, and provision of greater importance to co-curricular activities was evident in secondary education.

Regarding the second objective of the study it was found that employers of secondary level students expect an emphasis to be given to soft skills. The interviews helped to identify 18 vocational oriented competencies considered as important by the employers. Those are Language proficiency, Computer literacy, Communications skills, Efficiency, Leadership qualities, Team work, Creativity, Practicability, Personality, Management skills, Love to society, Good inter relationships, Problem solving skills, Commitment, Readiness to take up responsibility, Decision making skills, Analytical thinking and Risk taking. Among these priority was given to language proficiency and computer literacy. Views were also expressed that in the future there could be a less demand for physical labor.

The study enabled the researcher to identify several measures that could be implemented for the development of vocational oriented skills which could be incorporated in a programme of action. Students', teachers' and parents' perceptions on secondary education were identified. Moreover, students' expectations to develop vocational oriented competencies were identified. Each sample said that some marks should be given for vocational oriented competencies when students are selected for admission to higher education or recruited for jobs. The study stressed the importance of participation of employers in the formulation of education policies. The sample expressed the need to identify new trends through the study of the world of work and innovation education in parallel. Establishment of training institutions at zonal level for the development of vocational oriented competencies, establishment of a quality structure in curriculum development committees, reduction in the volume of subject matter in syllabi, provision of greater opportunities for the teaching of vocational oriented subject matter, introduction of a technical stream at senior secondary school level, training teachers for the development of vocational oriented competencies, subjecting vocational oriented competencies to evaluation at national examinations also, making participation in co-curricular activities compulsory, formalization of vocational guidance programmes and bringing about a change in societal attitudes.

The study analyzed the relationship between secondary education and world of work by comparing Teacher Instructional Manuals with selected national goals of education and basic competencies identified by the National Education Commission. It also analyzed identified vocational oriented competencies. The study found that there are more vocational oriented competencies included in the current secondary education curriculum.

RECOMMENDATIONS

Some important recommendations emerging from the study are as follows:

1. Reduction in the volume of subject matter in syllabi and increase of practical oriented activities.
2. Greater importance should be given to basket subjects
3. Introduction of a technical stream at senior secondary school level
4. Establishment of training institutions at zonal education level for the development of vocational oriented competencies.
5. Institution of a quality structure in curriculum development committees.
6. Training teachers for the development of vocational oriented competencies and awareness for the world of work.
7. Subjecting vocational oriented competencies to evaluation at national level examinations.
8. Formulation of an action plan aligned to the National Vocational Qualification (NVQ) level 3 & 4 at secondary school level.
9. Improve the practical relationship between secondary education and world of work.
10. Make participation in co-curriculum activities compulsory.
11. Formalization of vocational guidance programmes.
12. Bringing out a change in societal attitudes for secondary school education and the world of work.

Finally, it was possible to conclude that the development of vocational oriented competencies could be done in students at secondary level education if the existing academic orientation and examination dominance were minimized to bring about a change in the competitive pattern of education. Furthermore, the need to pay attention on education of, not only those who continue to the higher education level but also on the majority who drop out after their secondary education, was emphasized. It was clear that such programme of action would enable the creation of a future generation capable of facing the challenges of the world of work.

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HOW DOES COOPERATIVE LEARNING HELP TO INCREASE COMMUNICATION AMONG STUDENTS IN LEARNING SCIENCE?

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INTRODUCTION

More educators and psychologists value the benefits of cooperative learning strategies over those of a traditional teacher-centered classroom. Psychologists often speak about understanding joint construction. Piaget emphasized social interaction, more specifically peer interaction, from the perspective of its specific role in the development of logical reasoning (Hornby 2008).

According to the National Evaluation and Testing Service (NETS, 2010), the number of students in the science stream is less than the other streams in Grade 12 and 13 because achievements in the science and mathematics subjects are at a lower level at the Grade 11 General Certificate of Education for Ordinary Level (G.C.E O/L) examination. Even though several projects have been introduced at national, provincial and zonal levels, the achievements for science have not reached the expected level during recent years. According to my personal experience, the grade 7 class is an important level to create an interest in learning science.

This research was designed to explore whether and how cooperative learning supports the improvement of learning science of grade 7 students. A mixed methods approach was used, and the research question that was posed was “How does cooperative learning help to increase communication among the students in learning science?”

The Null Hypothesis (H_0) → The mean value of communication skills for learning science before implementing the cooperative learning approach (μ_1) is not less than the mean value of communication skills for learning science after implementing the cooperative learning approach (μ_2) ($\mu_1 \geq \mu_2$)

Alternative Hypothesis (H_1) → The mean value of communication skills for learning science before implementing the cooperative learning approach (μ_1) is less than the mean value of communication skills for learning science after implementing the cooperative learning approach (μ_2) ($\mu_1 < \mu_2$)

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MATERIALS AND METHODS

Based on the ease of access, 21 students from grade seven in one of the 1AB schools in the Kandy district were selected for this experimental study. We used a mixed methods approach to answer the posed research question. Firstly, a questionnaire was administered to assess the students' existing communication strategies for learning science. Subsequently, five lessons were designed based on the Student Team Achievement Method (STAD) under the cooperative learning approach for the 5th unit (properties, uses and interactions of substances) of a grade 7 science class. During the implementation of the five lessons, data was gathered as observations.

The collected data was analyzed using Excel 2007 where a paired t-test was conducted to analyze the data of the questionnaire to compare the development of communication prior to the lessons and after the implementation of the lessons that used a cooperative learning approach. Further, observational data was also analyzed using the thematic analysis technique and an assertion was also derived.

Sample and research instruments

21 students (8 males and 13 females) studying in Grade 7, at a 1AB Tamil medium school in the Kandy district, were selected for the study by using the purposive sampling method. A survey questionnaire was used to collect quantitative data. Teacher monitoring sheets, students' reflection forms, semi structured interview schedules and field notes were used to collect qualitative data.

Data collection

The survey questionnaires, developed for the purpose of assessing students' communication skills, were first administered to the students before starting the cooperative learning activities for science learning. During the implementation of the five lessons, students were made to engage in practical activities and were asked to complete activity sheets individually according to the teachers' instructions. Throughout the study, the author was an unobtrusive observer while the teacher conducted the lessons using the cooperative learning approach. During its implementation, the teacher assessed the students' communication skills using the teacher's monitoring sheet. Further, at the end of each lesson, the students' reflection forms, which consisted of the responses "none", "some", and "a lot" were given to the students to be completed, were collected. Field notes, which were maintained for each cooperative lesson activity and photographs, were also scrutinized.

After completing the five lessons, the same survey questionnaire was administered to the same students in order to find out any differences in their answers. Later, semi structured interviews were conducted for 10 students and 2 teachers. These interviews were audio recorded.

Data analysis

In the analysis of data, both qualitative and quantitative techniques were used. Quantitatively, the responses to the questionnaire were analyzed under the Likert scale. A t-test was run using Excel 2007 to determine whether a statistically significant difference existed between the means. The percentage values for the observed criteria and the unobserved criteria in the "teacher monitoring sheet" were determined. The frequency for each response and each criterion in the students' reflection form was calculated as a percentage. The recorded interview data was transcribed and an assertion was formulated.

RESULTS

Results from survey data analysis

The p-values for questions 9, 12, 15, 16, 18, 19, 20 and 22 were less than the significance value of 0.1. Therefore, the null hypothesis was rejected. Hence, it can be inferred that the communication skills for learning that existed before the implementation of the cooperative learning approach are less than the communication skills for learning that were acquired after the implementation of the cooperative learning approach.

Results from observational data analysis

During the present research study, several instruments were used to observe how cooperative learning activities impact on students' communication skills for learning science. Field notes and interview transcripts were used to formulate the assertion. The percentage responses for each item in the students' reflection form and the percentage of entries in the teacher monitoring sheet were also considered to provide evidence for the formulated assertion, which was "Cooperative learning motivates students' interaction for learning Science".

Assertion

Cooperative learning motivates students' interaction for learning Science

It was clearly observed that the students' interactions increased in the classroom when the five science lessons, which were developed based on the cooperative learning approach, were implemented. During the cooperative learning activities, students' improved interaction was the key observation that was noted as most of the time they were provided with opportunities to argue with others to demonstrate their points of view. Students discussed and argued with the teacher, as well as with other students, and clarified their doubts, which demonstrated that cooperative learning resulted in giving a good opportunity for fruitful interactions.

Lesson 1 (physical states of substances) consisted of material to find out properties such as hardness, fixed volume, definite shape, and compressibility by external force of given materials. At this juncture, students' interaction activities were noted after the experiment as follows:

...After that teacher asked them to pour the same water into the 250 ml beaker. Later the teacher asked them how much volume of water was in the 250 ml beaker, and whether there was any difference in the volume of water in the beaker. Students replied that there is only 50 ml of water in the 250 ml beaker. Then one of the students of this group asked the other students "is coconut oil a fixed volume or not?" The other students said that coconut oil is also a liquid substance like water so there is no variation, and that it is also a fixed volume. (Field notes dated 14.05.2012)

During the semi structured interview, the two teachers too emphasized on the impact of cooperative learning on the improvement on the learning of science by students. For instance, when interviewed, one of the teachers who observed the activity said that

"... [t]his method is really good because students are doing the tasks on their own. They compare and differentiate their problems with the participation of the whole group and at the end come to the conclusion unanimously. This is the most appropriate way for correct learning. It was observed that during the student's individual work their thinking prowess developed and during the group work their attitudes developed". (Voicerecord – 17, Lesson-4, 17/05/2012)

During the interview, the teacher said that students' abilities were different from each other. Each group consisted of clever and weak students. During cooperative participation for a given task, weak students were guided by the cleverer students, through these interactions, in order to achieve the expected level of knowledge.

Furthermore, the observations that were obtained through teacher monitoring sheets and students' reflection forms during the student's cooperative learning activities also revealed the improvement of students' interaction. These evidences reveal that students like to learn science through interactions and that cooperative learning activities provide an ideal environment to achieve it.

DISCUSSION OF FINDINGS AND CONCLUSION

This study explored the impact of cooperative learning on science learning in grade seven students. The improvement of students' communication skills for learning was obvious through both the survey and observational results. Students' communication skills, such as sharing ideas, working together, peaceful communication, and lower frustration and anxiety, were improved during cooperative learning. In addition, the findings from the analysis of the teacher monitoring sheets, as described in results, assured that the students' communication skills were improved in science learning under the cooperative learning approach. The analysis of the Student reflection form also revealed the improvement of students' attitude of respecting others' ideas. The expressions of the students and teachers during their interview also revealed that the students' communication skills were developed through the cooperative learning activities.

CONCLUSION

The results of the present study indicated that students favored to communicate with others and were motivated to learn science under the cooperative learning approach. This outcome agrees with the Bently and Watts (1989) statement that "students can increase each other's learning by the cooperative learning approach under the group discussion method". Furthermore, students express desirable attitudes to working together and say they feel confident of their learning under the cooperative learning approach.

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CAN THE COMPLETION RATE OF A COURSE BE INCREASED BY LOWERING THE ELIGIBILITY CUTOFF MARK IN CONTINUOUS ASSESSMENT?: A CASE STUDY

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INTRODUCTION

Formative and summative assessments play a vital role in any academic programme leading to a degree. Summative assessment appraises student learning with respect to learning outcomes and is essential for determining the terminal attainment of a student. As such, an end-of-course examination is a purely summative assessment. The facilitation of the teaching and learning process is the major role of formative assessment¹. Any evaluation activity that provides feedback to the learner, but is not used in determining the final grade, is a purely formative assessment.

Continuous Assessment (CA) is an assessment strategy that depends on the frequency of assessment events², and may have both formative and summative components. CA plays multiple roles in an Open and Distance Learning (ODL) study programme³. It motivates the isolated distance learner to study continuously throughout a semester, and thereby avoid last minute cramming for a Final Examination (FE). (Continuous engagement in studies is somewhat automatic in a study programme conducted in face-to-face mode where the learner has to attend lectures regularly.) CA improves communication between the instructor and learner through the provision of continuous feedback and builds up confidence in the learner³. Due to its importance, ODL institutions not only include a certain fraction of the CA Mark (CAM) in the final grade, but also set thresholds in the CAM that must be attained to obtain a pass grade in a course⁴. This threshold condition may be viewed as an interim goal set in enhancing motivation and improving engagement by the student in the learning process.

Each course, with a non-zero credit rating, offered in the BSc in Natural Sciences programme at the Open University of Sri Lanka (OUSL) has both CAs and a FE. The Overall Mark (OM) is the average of the CAM and the FE Mark (FEM). A student is considered eligible to sit the FE of a course only if he/she has attained a $CAM \geq 40\%$. This eligibility cutoff in the CAM (i.e. 40%) is a threshold condition imposed on the CAM. It is important to note that the minimum attainment in the OM to acquire a pass grade in a course is also 40%.

If one considers only the formative aspect of CA, then he/she can question whether setting the threshold in a CAM that is equal to the pass mark in OM is reasonable since a student with a $CAM < 40\%$ may be able to improve and score a higher mark in the FE, and thereby obtain an OM that is required for a pass grade. If that is the case, then the completion rates of courses (defined as the fraction of students who obtain a pass grade in a course, out of the students who have registered in the course) may be improved by decreasing the eligibility cutoff in the CAM, and thereby allow more students to sit the FE. One cannot answer this question by just examining the available CAMs and FEMs (or OMs) of the students in a course since the FEMs of students having an $CAM < 40\%$ are not available simply because such students do not sit the FE. The work reported here is a case study undertaken on the course (coordinated by the author), CMU2220 - Concepts in Chemistry, at OUSL to search for an answer to the above question.

CMU2220 is a course at Level 4 (equivalent to the 2nd year in a conventional university) of

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the BSc in Natural Sciences programme. It is conducted over two semesters and has an OUSL credit rating of 6 (240-300 notional learning hours). It has a 5-day laboratory component that is assessed continuously in the laboratory itself, and which leads to a Practical Assessment Mark (*PAM*). Continuous assessment of the theory component involves 3 CA Tests (CATs) of one-hour duration each. The Theory (continuous) Assessment Mark (*TAM*) is a weighted average of the 3 CAT marks. The *CAM* is calculated as a weighted average of both the *TAM* and the *PAM*.

The OM is calculated according the following rules:

$$OM = \begin{cases} FEM & \text{if } FEM < 30\% \\ (CAM + FEM)/2 & \text{if } 30\% \leq FEM < 40\% \\ (CAM + FEM)/2 & \text{if } FEM \geq 40\% \end{cases} \quad \text{subjected to a maximum of 40\%} \quad (1)$$

Research questions:

1. Do the continuous assessment in the CMU2220 course fulfill its formative role by enhancing student learning?
2. Is it possible to increase the number of students attaining a pass grade in the CMU2220 course by lowering the eligibility cutoff in the *CAM* to below 40%?

METHODOLOGY

The population of students studied consists of all who sat the FE in the CMU2220 course in the academic years 2011/2012 and 2012/2013. The course delivery methods and assessment techniques were uniform over these two years. The total population size was 206. After a careful study of a scatter plot of the *FEM* versus the *CAM*, three were rejected as extreme cases, resulting in the population that was used in studying correlations to be 203. Each student was represented by a couple of values (*CAM and FEM*) in the study. The linear correlation between the *FEM* and the *CAM* was examined in answering the first research question.

In answering the second research question, first, the 203 data points (*CAM and FEM*) were binned based on the *CAM*. Then, for each bin, a relative frequency polygon, $F(FEM; \beta)$, of the *FEM* was constructed using the data points in it. This polygon was assumed to represent the *FEM* distribution at the *CAM* corresponding to the midpoint of the bin, represented by $CAM = \beta$. This assumption becomes better and better when the bin width decreases (and becomes exact in the limit of zero bin width). This approximation is at the same level of precision as the assumption frequently made in converting a histogram into a frequency polygon. Then, $f(\alpha; \beta)$, defined

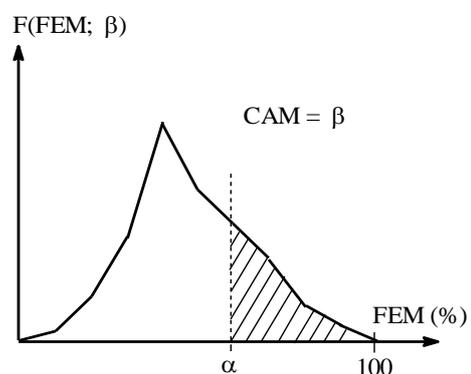


Figure 1: Relative frequency polygon of *FEM* at $CAM = \beta$

by $f(\alpha; \beta) = \frac{\int_{\alpha}^{100} F(x; \beta) dx}{\int_0^{100} F(x; \beta) dx}$ gives an estimate of the fraction of students with a *FEM* $\geq \alpha\%$ and a $CAM = \beta$ in the population of students under study. In Figure 1, $f(\alpha; \beta)$ represents the shaded area under the frequency polygon as a fraction of the total area

under the same frequency polygon. For a given value of α , $f(\alpha;\beta)$ may be viewed as a continuous function of β , i.e. *CAM*. Hence, as shown later, $f(\alpha;CAM)$ can be extrapolated to a *CAM* that is below the eligibility cutoff (where *FEM* data is nonexistent) to reveal valuable information that is necessary in answering the second research question.

RESULTS AND DISCUSSION

The scatter plot of the *FEM* versus the *CAM*, with its linear regression curve, is shown in Figure 2. The Pearson’s correlation coefficient is 0.63 ($p < 0.01$). According to Borg and Gall⁵, a correlation coefficient between 0.65 and 0.85 makes possible group predictions (of one quantity using the other) that are sufficiently accurate for most purposes in education. The correlation of the *FEM* and the *CAM* in the CMU2220 course has almost reached the said range. Hence, one may safely say that, in general, the *FEM* increases with an increasing *CAM*. In other words, CA has improved the learning of students as reflected in the summative assessment mark, the *FEM*. This, in turn, suggests that CA has fulfilled its formative role.

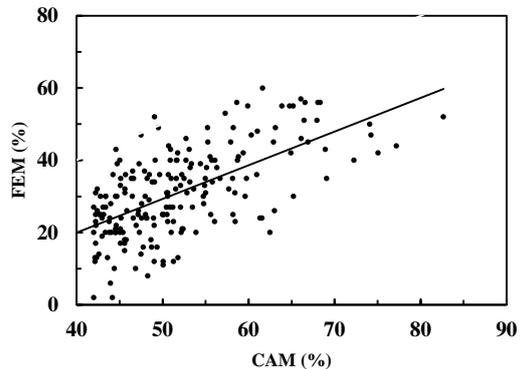


Figure 2: FEM Versus CAM

Examination of the *FEM* and the *CAM* revealed that only 3 students, out of 206, have obtained a *FEM* greater than his/her *CAM*. Hence, we conclude that CA has not led to an improvement of the *FEM* over the *CAM* in a large majority (98.5%) of students, although it has improved their learning.

Bining, according to the *CAM*, commenced at *CAM* = 42% (the minimum *CAM* in the population) and each bin had a width of 3%. Figure 3 depicts the plots of $F(FEM;CAM)$ constructed for the 3 bins (42%–45%), (45%–48%) and (48%–51%). As expected, the distributions of the *FEM* shift to higher values of the *FEM* with an increasing *CAM* due to a substantial positive correlation between the *FEM* and the *CAM*. Using these three distributions, three $f(40%;CAM)$ were calculated that are considered as the values of $f(40%;CAM)$ at *CAM* = 43.5%, 46.5% and 49.5%, respectively. Figure 4 shows the scatter plot of $f(40%;CAM)$ versus the *CAM* with the corresponding linear regression curve. We found that the correlation between $f(40%;CAM)$ and the *CAM* is perfect with a Pearson’s correlation coefficient of

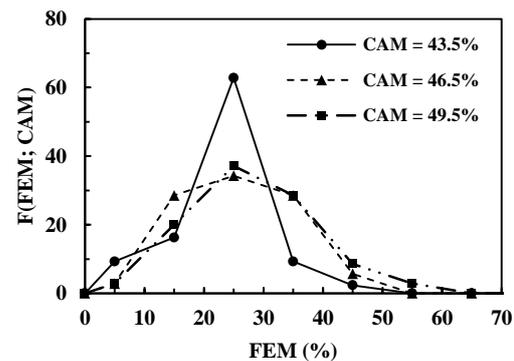


Figure 3: Relative frequency polygons of FEM at 3 different CAMs

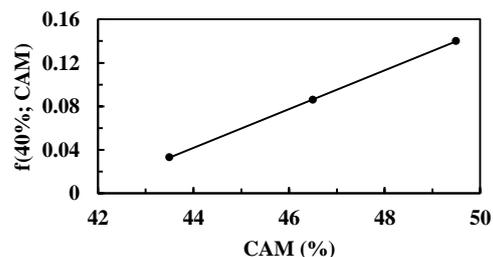


Figure 4: Scatter plot of $f(40%;CAM)$ versus CAM

0.99997 ($p < 0.01$). Hence, the corresponding linear regression curve can be used in estimating $f(40\%;CAM)$ at any CAM close to the interval 42% – 51%. Extrapolation of the curve revealed that $f(40\%;CAM) = 0$ at $CAM = 41.6\%$. This means that the minimum CAM required to have a $FEM \geq 40\%$ is 41.6%. However, the width of a bin introduces an uncertainty in this estimate of a minimum CAM that is, at most, half the width of a bin; viz. $\pm 1.5\%$. This uncertainty pushes the estimated minimum CAM for obtaining a $FEM \geq 40\%$ down to 40.1%. Hence, we conclude that it is highly unlikely that a student with a $CAM \leq 40.1\%$ can obtain a $FEM \geq 40\%$ by sitting the FE.

In other words, a student who attains a $CAM < 40\%$ will almost certainly attain a $FEM < 40\%$ if he/she sits the FE. Since the OM is, at most, the average of the FEM and the CAM (see equation (1)), such a student cannot attain a $OM \geq 40\%$ and, hence, cannot obtain a pass grade. Hence, we conclude that completion rates in CMU2220 cannot be increased by lowering the eligibility cutoff in a CAM to below 40%.

The total number of sets of marks (FEM and CAM) that fall into a bin in a CAM decides the precision of the construction of the corresponding relative frequency polygon in a FEM . This could be increased by increasing the width of a bin. However, increasing bin width increases the uncertainty in a CAM , as described above. Three bins used in the calculation had 43, 35 and 35 sets of marks. More precise results could have been obtained if we had a larger population.

In this study, we implicitly assumed that any other parameters, such as motivation, which affects completion rates, do not change with the lowering of the eligibility cutoff in a CAM . However, this may not be so. For example, motivation may diminish if one substantially lowers the eligibility cutoff. However, such a change will only lead to a reduction the completion rate.

CONCLUSIONS/RECOMMENDATIONS

The continuous assessment in the CMU2220 course has enhanced the learning of students indicating that it has fulfilled its formative role. However, only a very small fraction (1.5%) of students attained a FEM larger than their CAM .

It is highly unlikely that one can increase the completion rate in the CMU2220 course by reducing the eligibility cutoff of the CAM to below 40%.

Although we have specifically studied students of the CMU2220 course, the methodology developed here is general and may be applicable to other courses with a substantial correlation between the FEM and the CAM .

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**A COMPARATIVE STUDY ON THE SUPPORT RECEIVED BY STUDENT
TEACHERS DURING THE TEACHING PRACTICE STAGE I OF THE POST
GRADUATE DIPLOMA IN EDUCATION PROGRAMME**

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INTRODUCTION

Post Graduate Diploma in Education (PGDE) is the basic professional qualification for Graduate teachers in Sri Lanka. The Open University of Sri Lanka conducts the PGDE programme through the distance mode with the aim of improving the professional competencies of Graduate teachers in the school system. Teaching practice is an important component for becoming a teacher (Kiggundu & Nayimuli, 2009). Teaching Practice is a major component of PGDE programme and is conducted in two stages. The stage I takes place at student teachers' own schools for a period of 10 weeks. School principals exercise significant influence on teachers' professional development. Bredeson (2000) states that, the role of the school principal is to encourage, nurture and support teacher learning.

The student teachers are allowed to do their teaching practice at their own schools with the support of their principals, mentors, colleagues and master teachers. According to Reddy & Sekhar (2011), the task of a mentor is to define a unique relationship with his or her apprentice and fulfill a need unmet by any other relationship. Further, Mentor is someone who gives help and advice over a period of time. He/she supports, guides and counsels a young adult as he/she accomplishes mastery of the adult world or the world of work. Further, Co-operative and friendly collegial relationships, open communication and free exchange of ideas may be sources of emotional and psychological support for teachers' work and promote their professional development (Geijsel et al., 2001).

Every year nearly 400 Master teachers are appointed by the Faculty of Education to evaluate teaching practice stage I. The faculty expects the Master teachers to provide necessary guidance and support for the development of teaching skills of their student teachers. During teaching practice, student teacher is given opportunities to try the art of teaching before actually getting into the real world of the teaching. From 2009/2010 academic year the University has taken steps to appoint school Mentors to provide further support to these student teachers. The present study attempts to compare the support received by the student teachers who registered at Colombo and Jaffna Regional Centres of the Open University of Sri Lanka.

The objectives of the study are

- to compare the support received by the student teachers registered at Colombo and Jaffna Regional Centres from their ;
 - master teachers
 - school mentors
 - colleagues
 - principals
 - and

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- to make suggestions to improve the support from relevant stakeholders to the student teachers during teaching practice stage I

METHODOLOGY

The survey research design was used for this study. The population of this study was student teachers registered for the Post Graduate Diploma in Education Programme at the Open University of Sri Lanka in the 2011/2012 academic year. The sample consisted of 150 student teachers from Jaffna Regional Centre and 250 student teachers from Colombo Regional Centre. The main data collection instrument was the teachers' questionnaire which included some open ended questions as well. Data analysis was done by using quantitative and qualitative techniques.

RESULTS AND DISCUSSION

Majority of the student teachers from both centres mentioned that they have received enough support from their principals to improve their performance of the teaching practice stage I. The following table shows their responses for each type of support.

Table 1: Support received from principals as percentages

Supports	To a great extent		To some extent		To a least extent		Not at all	
	JRC	CRC	JRC	CRC	JRC	CRC	JRC	CRC
Motivating	53	54	45	25	-	21	02	-
Sharing his/her previous own experiences of teaching practice	21	42	61	21	10	12	08	25
Ready to allow/adjust any needed changes regarding teaching practice	37	58	49	30	12	12	02	-
Provide suitable time table	82	66	18	26	-	08		-
Provide necessary quality inputs to use for teaching-learning processes	61	66	35	21	04	08	-	05
Support to arrange the classroom in a suitable place	62	66	26	21	12	08	-	05
Give support to Master teachers	76	71	24	21	-	08	-	-
Support to appoint a mentor	80	71	18	21	02	08	-	-
Give support to the mentor	76	71	22	21	02	08	-	-

According to the data given in the table, 82% of the student teachers registered at Jaffna Regional Centre (JRC) agreed to a great extent that their Principals supported them by providing suitable time tables. But only 66% of CRC student teachers agreed to this statement. Compared to JRC, more student teachers from CRC agreed to a great extent that their principals supported them by motivating them, sharing their experiences, adjusting needed changes regarding teaching practice and by providing necessary quality inputs. The above table reveals that compared to other aspects, at JRC and CRC fewer number of teachers

agreed that their principals shared their experiences. For an open ended question related to the problems faced, most of them mentioned that they were unable to find time for preparation as their principals forced them to teach more than 36 periods per week. However, a large proportion of student teachers from JRC mentioned that their principals gave support to Master teachers and mentors, to appoint mentors and provided suitable time tables. It may be inferred that support provided by the principals of CRC student teachers is higher than that of the JRC student teachers.

For the question related to the mentors' support, almost all the teachers from both centres stated that they have received enough support from their mentors to improve their performance of the teaching practice stage I. Table 2 gives details.

Table 2: Support received from mentors as percentages

Supports	To a great extent		To some extent		To a least extent		Not at all	
	JRC	CRC	JRC	CRC	JRC	CRC	JRC	CRC
Motivation	70	84	28	16	02	-	-	
Sharing his/her previous own experiences of trainee of teaching practice	60	67	32	33	08	-	-	-
Ready to adjust any needed changes regarding teaching practice	66	84	28	16	06	-	-	-
Provide support to prepare teaching aids	43	62	42	30	15	08	-	-
Provide support to plan the lesson	45	62	47	30	08	08	-	-
Give guide lines to use quality inputs in an effective way in the teaching learning process	47	62	40	30	13	08	-	-
Support to arrange the classroom in a suitable place	53	67	34	20	09	13	04	-
Give support to identify suitable methods of teaching	45	75	42	16	13	09	-	-
Guide to maintain good relationship with Principal	57	70	28	25	06	05	09	-
Give support to the master teacher to carry out his/her duty.	64	87	26	08	02	05	08	-
Guide to identify significant problem for project	68	84	26	16	06	-	-	-
Give support to complete the project in time.	75	62	19	30	06	08	-	-
Give guidance to write reflection	62	62	30	30	08	08	-	-

Table 2 clearly reveals that, in JRC and CRC student teachers were highly motivated by their mentors. One of the main duties of school mentor is to guide student teachers to complete a project during their teaching practice stage I. Compared to student teachers at CRC, more student teachers at JRC agreed to a great extent that their mentors gave support to complete

their project in time but in all other aspects student teachers at CRC rated the highest percentage. Student teachers at JRC mentioned that their mentors did not support them to arrange classrooms in suitable places (4%), to maintain good relationship with principals (9%) and to support Master teachers to carry out their duties (8%).

When teachers were asked about the support they received from their colleagues the following responses were obtained.

Table 3: Support received from colleagues as percentages

Supports	To a great extent		To a some extent		To a least extent		Not at all	
	JRC	CRC	JRC	CRC	JRC	CRC	JRC	CRC
Motivation	53	75	43	17	04	08	-	-
Sharing his/her previous own experiences of trainee of teaching practice	47	75	39	17	10	08	04	-
Adjust any needed changes regarding teaching practice	42	58	48	38	08	04	02	-
Provide support to prepare teaching aids	43	66	37	25	18	09	02	-
Provide support to plan the lesson	36	58	44	33	12	09	08	-
Give guide lines to use quality inputs in an effective way in the teaching learning process	43	63	43	20	14	17	-	-
Support to arrange the classroom in a suitable place	45	63	39	33	12	04	04	-
Support to identify suitable methods of teaching	40	75	44	17	10	04	06	04
Guide to maintain good relationship with Principal	53	80	37	12	04	-	06	08
Give support to the Master teacher to carry out his/her duty.	57	76	35	12	02	12	06	-

As shown in Table 3, compared to JRC student teachers, those who are attached to CRC agreed that their colleagues have supported them to a great extent. However 6% from JRC and 4% from CRC agreed that their colleagues did not support them to identify suitable teaching methods. Further, 6% from JRC and 8% from CRC stated that their colleagues did not guide them to maintain a good relationship with their principals.

Table 4: Support received from master teachers as percentages

Supports	Fully satisfy		Satisfy		Not satisfy		Completely not satisfy	
	JRC	CRC	JRC	CRC	JRC	CRC	JRC	CRC
Conducted first meeting on time	58	83	38	17	02	-	02	-
Provided enough instructions	50	75	46	25	04	-	-	-
Follow the instructions given by the Open University	65	83	31	17	04	-	-	-
Made the first visit within two weeks	73	66	25	17	-	-	02	17
Gave Feedback on scheme of work	48	83	48	17	02	-	02	-

Gave Feedback on writing lesson plans	52	83	44	17	02	-	02	-
Gave Feedback on writing behavioural objectives for each lesson	50	83	44	17	04	-	02	-
Gave Feedback on preparation of teaching aids	45	83	45	17	10	-	-	-
Feedback on usage of teaching aids and teaching methods	42	58	48	38	06	04	04	-
Feedback on selection of teaching methods	38	58	56	38	03	04	03	-
Feedback on writing student activities in the lesson plans	46	58	50	30	04	12		-
Feedback on writing and teacher activities in the lesson plans	44	58	52	30	04	12		-
Feedback on writing evaluation methods	44	58	52	30	04	12		-

Student teachers' responses regarding the support from their Master teachers are shown in Table 4. The study reveals that 83% of the student teachers registered at CRC and 58% at JRC expressed their full satisfaction in conducting first meeting on time. But 2% of the teachers from JRC were not satisfied with this statement. Compared to CRC, most teachers from JRC expressed their full satisfaction with this aspect. Compared to CRC most teachers from JRC mentioned their full satisfaction regarding the first visit of Master teachers. However, 17% of the student teachers at CRC expressed their dissatisfaction for this aspect. Compared to JRC, more student teachers from CRC expressed their full satisfaction on this aspect. Compared to JRC, most teachers in CRC have expressed their full satisfaction in some areas such as providing instructions and following the instructions given by OUSL.

It could be concluded that in relation to teaching practice stage I, in both centres, principals, mentors and colleagues have supported student teachers to a satisfactory level. On the other hand master teachers also have played their role to some extent. But there were some problems. In some aspects, the support provided by the master teachers differs between the two centres. Therefore, the Faculty needs to take necessary actions to improve the contribution of master teachers and school society in teaching practice stage I. As the Open University of Sri Lanka follows a regular mechanism in the implementation of teaching practice stage I, no significant differences were observed between the two centres.

RECOMMENDATIONS

The following recommendations are based on the findings of the study. Faculty should

1. Take necessary actions to train Master teachers periodically to improve their knowledge in writing lesson plans, preparation and usage of teaching aids and selection of teaching methods.
2. Pay more attention to monitor the input of Master teachers of JRC.
3. Follow a mechanism to regulate Master teachers' visits to the schools for the supervision.
4. Make necessary arrangements to improve the support of school society particularly Principals and Mentors in teaching practice stage I.
5. Conduct a study island wide to investigate the factors influencing the performance of Master teachers and Mentors.

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UTILISATION OF 'AS GENERATED' QUARRY DUST AS A FINE AGGREGATE IN CONCRETE

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INTRODUCTION

The use of quarry dust as an alternative to traditionally used fine aggregate in concrete has drawn the attention of researchers and investigators over the last several years (Rajapaksha and Sooriyaarachchi, 2009; Ilangovana et al. 2008, Ho et al. 2001). Aspects such as cement requirement, workability, compressive strength and the cost of quarry dust concrete have been studied in the Sri Lankan context (Mathanraj et al., 2011, Rajapaksha and Sooriyaarachchi, 2009 and Nishanthie and Dias, 2010). Nevertheless, in Sri Lanka, there is still a hesitation to use quarry dust as a fine aggregate due to the presence of a high content of finer particles in fresh quarry dust. Moreover, the samples of quarry dust that were used in the testing programmes of these studies are the ones in which particles size distribution (PSD) curves are well placed within the upper and lower bounds according BS 882 recommendations for fine aggregates. This necessitates further studies which tests properties of concrete using, 'as generated' (or rather 'as supplied') quarry dust.

Quarry dust is a by-product formed particularly when metal is produced from rubble in metal crushers. There are two types of crushers in use of which the crushing mechanism differs. They are namely the jaw crusher and the cone crusher. With the jaw crusher, trubbles are placed between the jaws and crushed through an impact, whereas with cone crusher, rubble is crushed due to the rotation of cones. In no crusher site, quarry dust which is the by-product of metal is sieved before being piled up for disposal. There is no evidence of a study carried out in Sri Lanka to investigate the variance of the PSD of quarry dust in relation to crusher type. This is important on account of the difference of crushing techniques which could lead to varying gradations.

This study aims to check the feasibility of substituting river sand with 'as generated' quarry dust with as a fine aggregate in nominal concrete mixes. The objectives of the study are as follows:

1. To determine the PSD of 'as generated' quarry dust obtained from crusher plants in the Western and Eastern provinces.
2. To investigate the feasibility of using 'as generated' quarry dust in nominal concrete mixes without the removal of fines by washing or re-gradation.

METHODOLOGY

Fresh 'as generated', quarry dust samples were collected from sixteen different crushers in the Western and Eastern provinces. In total, 16 crushers were visited eight each in the Western Province (WP) and Eastern Province (EP). The samples were collected from piles of quarry dust dumped at each crusher location and labeled WP1-WP8 and EP1-EP8. In order to draw a PSD curve for each sample, sieve analysis was performed and the PSD curves of only four samples were drawn on one chart to avoid cluttering. The eight samples collected from each province were divided into two groups in this manner. To account for the variation of gradation among quarry dust samples, each taken from a separate crusher was tested in four groups. The purpose was to see how the PSD curves of the samples fit within the lower and upper bounds as per BS 882. From each group, the least suitable sample was selected for the

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preparation of mixes since the aim of the study was to test the feasibility of using 'as generated' quarry dust.

The three grades of concrete considered for the study are namely 20, 25 and 30, which are widely used in structural concrete. The concrete used for the casting of cubes was prepared using volume batching. The nominal mixes were prepared according to the mixes specified in Table 4.4 of ICATD publication SCA /4/1 which in turn is based on BS1881, Part 116. A total of 72 test cubes were cast with quarry dust as the fine aggregate and 18 were cast with river sand as the fine aggregate. They were both tested for compressive strength in 7 and 28 days.

RESULTS AND DISCUSSION

The locations and type of crusher from which the samples were generated are depicted against the sample name in Table 1. While in the Western province both types of crushers are equally popular, in the Eastern province, 75 per cent of the crushers are of the Jaw type; samples have been selected to be representative of the crusher prevalence.

Table 1: Details of samples collected from Western and Eastern provinces

Western			Eastern		
Sample	Location	Type of crusher	Sample	Location	Type of crusher
WP1	Malvana	Jaw	EP1	Ampara	Jaw
WP2	Kirindiwela	Jaw	EP2	Hingurana	Cone
WP3	Delgoda	Cone	EP3	Ugana	Jaw
WP4	Kotadeniyawa	Cone	EP4	Mahiyangana	Cone
WP5	Hokandara	Cone	EP5	Velikanda	Jaw
WP6	Kotadeniyawa	Cone	EP6	Kantalai	Jaw
WP7	Matugama	Jaw	EP7	Kantalai	Jaw
WP8	Matugama	Jaw	EP8	Valathapitiya	Jaw

The least suitable sample in each group (namely, WP1 to WP4, WP5 to WP8, and EP1 to EP4 and EP5 to EP8) with respect to gradation, was used as the fine aggregate in preparing test cubes. Figures 1 to 4 depict the PSD curves of four groups of samples. In the Western province, the two groups of samples WP3 and WP8 are the least suitable with respect to gradation. The PSD curve for sample WP3 lies outside the lower bound curve for smaller sieve sizes. However, the PSD curve for sample WP8 lies within the upper and lower bounds throughout. As for the samples from the Eastern province, the two least suitable samples are EP2 and EP7, and the PSD curves of both these lie within the upper and lower bounds.

The standard concrete cubes cast with the least suitable quarry dust samples and sand were tested for compressive strength; the results are compiled in tables 2 and 3. According to tables 2 and 3, mixes with quarry dust as fine aggregate records higher compressive strength than those that had sand as a fine aggregate for both grades 25 and 30. Quarry dust being a generated material rather than a natural aggregate is well graded and has a rougher surface texture due to crushing. While the property of 'well gradedness' offers increased bonding, rougher surface texture offers friction to movement between particles, both effects contributes to increased compressive strength.

Nevertheless, for grade 20, this is vice versa. As can be expected, this phenomenon is common for both 7 and 28 days compressive strength. It is also observed that this increase in strength is far higher for grade 25 than for grade 30. Since quarry dust contains a higher content of fines than sand, it has a greater specific surface area. As a result, quarry dust concrete will require a higher content of cement paste to cover the surface. Since Grade 20 concrete contains relatively low cement content, this situation will result in less cement paste being available for bonding and thereby lower compressive strength. According to Rajapaksha and Sooriyaarachchi (2009), the difference in the recorded strength is greater for

higher grade concrete, grades 30 and 50 in particular. This situation is well demonstrated in figures 5 and 6, which use average values.

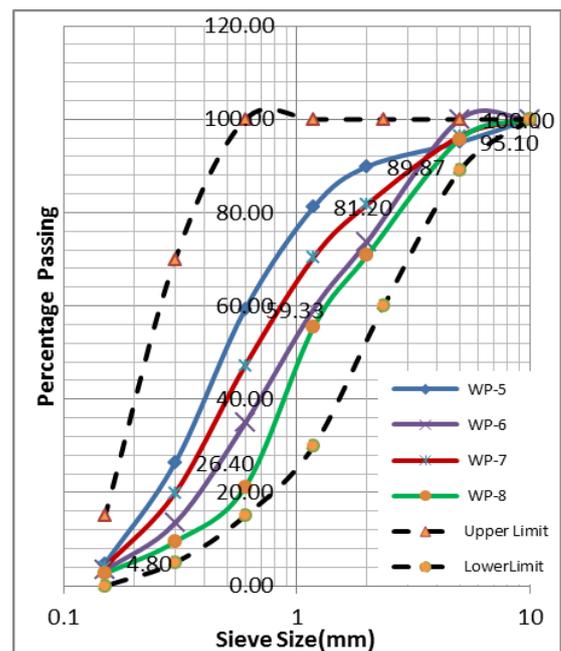
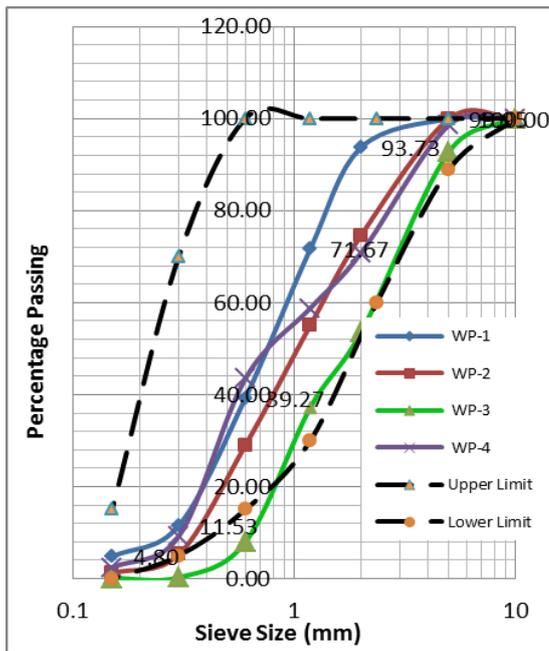


Figure 1: Particle size distribution for WP1–

Figure 2: Particle size distribution for WP5–WP8

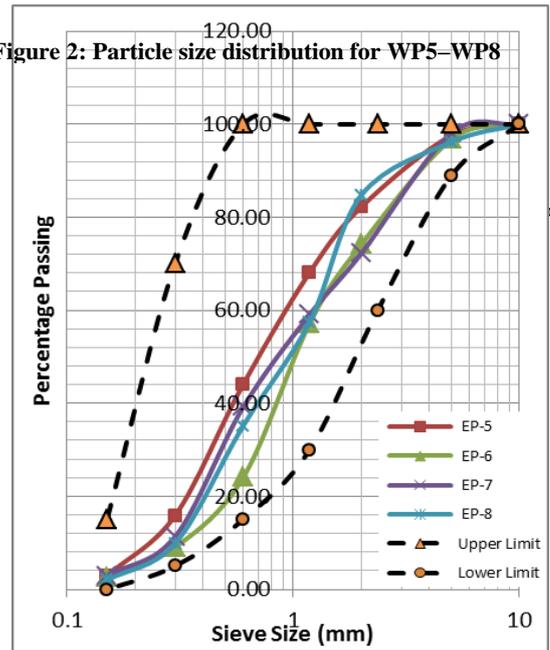
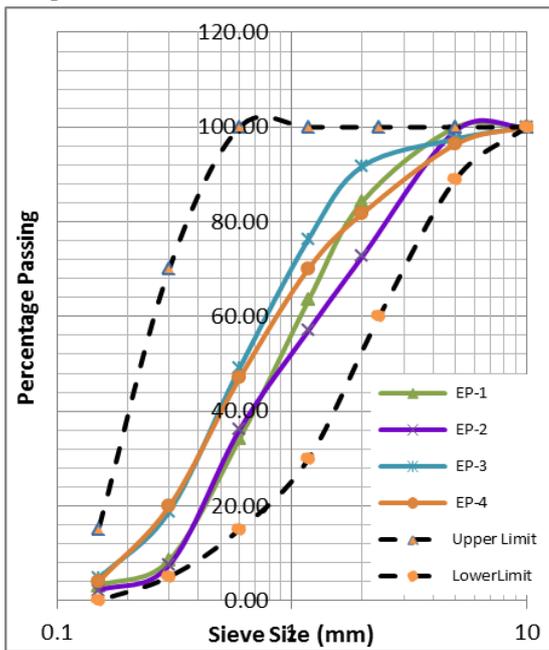


Figure 3: Particle size distribution for EP1–EP4

Figure 4: Particle size distribution for EP5–EP8

Table 2: Compressive Strength of concrete at 7 and 28 days - quarry dust as fine aggregate

Specific Mix	Grade	Compressive strength at 7 days (MPa)					Compressive strength at 28 days (MPa)				
		WP3	WP8	EP2	EP7	AVG	WP3	WP8	EP2	EP7	AVG
1:1:2	30	26.67	26.44	26.69	26.43	26.56	39.56	36.89	43.56	42.67	40.67
1:1.5:3	25	22.22	20.89	21.78	21.35	21.56	29.56	28.44	30.00	28.22	29.06
1:2:4	20	16.67	17.2	16.88	16.18	16.84	20.89	20.22	20.89	20.44	20.61

Table 3: Compressive Strength of concrete at 7 and 28 days - river sand as fine aggregate

Specific Mix	Grade	Compressive strength at 7 days (MPa)			Compressive strength at 28 days (MPa)				
		S1	S2	AVG	S1	S2	S3	S4	AVG
1:1:2	30	30	20.22	20.11	31.56	31.33	30.89	31.11	31.22
1:1.5:3	25	25	18.00	18.11	28.22	28.00	27.56	28.22	28.00
1:2:4	20	20	17.33	17.22	22.22	22.00	22.22	22.44	22.22

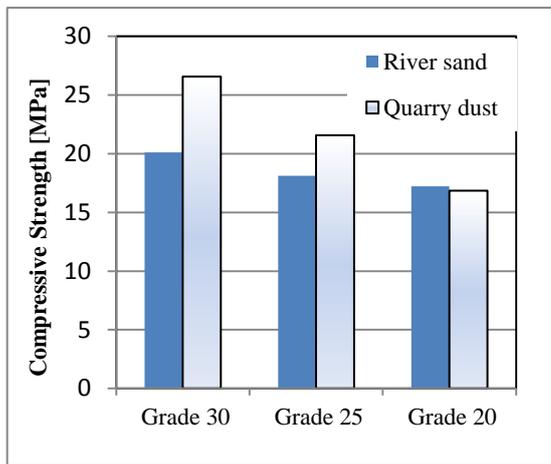


Figure 5: Compressive Strength - 7days

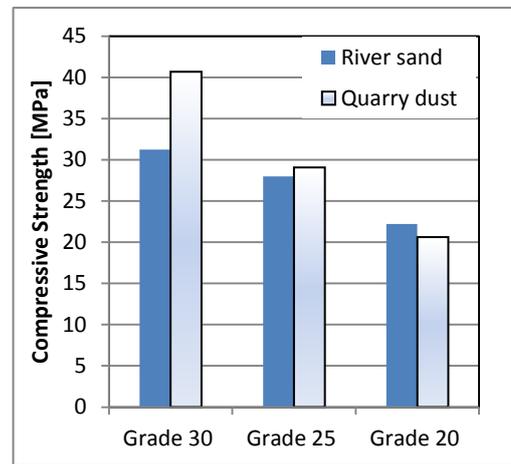


Figure 6: Compressive Strength - 28 days

CONCLUSIONS

Based on the above discussion, the following conclusions are drawn:

- The difference in gradation among quarry dust samples in both provinces is not significant; out of the 16 samples, the PSD curve of one sample lied outside the lower bound.
- Concrete produced with quarry dust records an appreciably higher compressive strength than the same produced with river sand for grades 25 and 30 concrete. As for grade 20, quarry dust concrete records a lower compressive strength than river sand concrete.
- As generated quarry dust can be recommended to be used as a fine aggregate in structural concrete for higher grades.

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MARITIME BOUNDARY GEO-FENCING WITH ENHANCED ACCURACY

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INTRODUCTION

With the influence of the North Equatorial ocean currents flowing around more than half of the Sri Lankan coast, the seas around the island are rich with fish. From ancient times, fishermen have been harvesting this valuable resource. Even today, the Sri Lankan economy is considerably dependent on the fishing industry. At the same time, fishing is a global industry where advanced technologies have been invented to boost the harvest. Satellite aided fish locating and multi-day trawler fishing boats equipped with navigational facilities have given an added advantage over traditional fishing techniques. Amidst all these technological advances, there are a considerable majority of fishermen who still rely on traditional fishing methods due to financial constraints.

Without the help of navigational facilities, fishermen's reach is limited and they are unable to explore distant international seas. However, in their eagerness to search for richer fishing grounds, some cross the maritime boundary between Sri Lanka and India (Figure 1). On the other hand, the absence of physical boundaries in the middle of the sea too paves way to traditional fishing boats running into foreign territories unknowingly. Both Sri Lankan and South Indian fishermen frequently cross the Indo-Lanka maritime boundary which has led to severe consequences.



Figure 1: Indo-Sri Lanka maritime boundary

Source: <http://www.lankanewspapers.com>

To overcome this burning problem, several steps have been taken to develop low-cost, yet powerful, maritime geo-fencing systems. Some of them are based on smart phones equipped with global positioning system (GPS) (Kaplan, 2006) receivers and relevant maps in which the boats' movements are monitored and displayed on maps. Usually the GPS receivers in these smart phones possess poor accuracy which has led to erroneous readings.

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Dedicated systems like GPS72H (Garmin, 2009) in which a more accurate GPS receiver is included, provide better accuracy in boat movement monitoring. However, the low battery life and the need for manual reading have made these systems less successful in maritime geo-fencing. In particular, the requirement for manual checking for a boundary crossing is not feasible for busy fishermen. An alternative system has been proposed in (Suresh Kumar & Sarath Kumar, 2010) and improved upon later in (Karthikeyan *et al.*, 2012 & Samuel *et al.*, 2014 & Girja *et al.*, 2014), where a fully automatic GPS positioning and geo-fencing is carried out by a microcontroller-based control circuit. The key concept in the automated geo-fencing algorithm employed here is that the boundary is modeled as a collection of straight line segments. Here the discrete points' boundary data are stored in a database. When the current GPS coordinates are detected, the two nearest points (on either side) are used to determine the equation of a line with respect to which the current relative position is determined. There are two clear drawbacks of this approach. First, the calculations involved add a considerable delay in addition to the delay added by the database search. Secondly, the alarm is generated only after the boundary is crossed, whereas the requirement is to alert the fishermen before they cross the boundary.

As a solution to these problems, this paper presents the design of a maritime boundary geo-fencing system which monitors the movement of a vessel, identifies a possible boundary crossing and alerts the fishermen before the boundary is crossed, with an enhanced accuracy.

METHODOLOGY AND DESIGN

The proposed system consists of two main sub units, respectively dealing with position detection and boundary checking. The position detection system is equipped with a GPS receiver circuit which obtains the GPS coordinates from satellites (Figure 2). Note that, in the middle of the sea without barriers like foliage or buildings, it is always guaranteed to have the minimum required number of four satellites for accurate position detection provided that good weather conditions exist. In the presence of a cloudy sky, the receiver produces GPS coordinates with a deteriorated accuracy. The GPS signals are captured every 120 seconds and the coordinate information is extracted from the GPS signal. The selection of the GPS capturing time of 120 seconds is due to a battery power saving mechanism, where the control, alarm and GPS receiver units enter a sleep mode periodically.

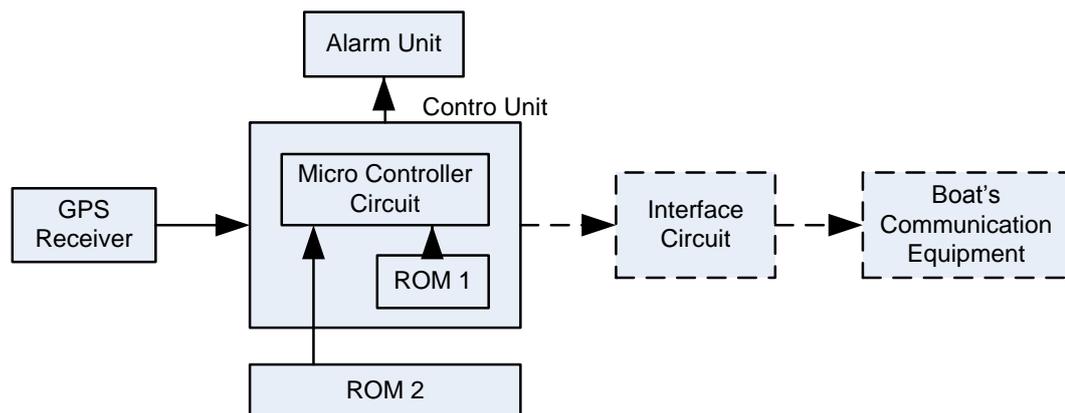


Figure 2: Block diagram of the proposed system

The boundary checking system consists of a database (Figure 3) stored in a read-only-memory (ROM), (ROM2 in Figure 2) which contains the data corresponding to the boundary. These data points are generated by dividing the map into equal-sized rectangles and recording the center coordinates of the rectangles which are along the boundary. It is obvious that smaller the rectangles, the accuracy of the checking would increase. However, this would also increase the database size. Therefore, a tradeoff between database size and the accuracy is to

be met by selecting the size of these rectangles. One of the major contributions in this paper is the introduction of the concept of the virtual boundary where a boundary within 2km inside the actual boundary is considered and stored in the database. Thus, the fishermen get the alert before the boundary is crossed, and also, this concept allows to eliminate the mathematical calculations used in (Suresh Kumar, 2010) and to rely only on a database search. The received coordinate's latitude value ($= y_0$) is used for searching the corresponding longitude value, x_0 of the boundary. A very important thing to note here is that, in order to make the search efficient and fast, a binary search algorithm is followed. Then this boundary value x_0 is compared to the longitude value of the current position, x to detect a boundary crossing as shown in Figure 4. In the case of a boundary crossing, an alarm is generated to alert the fishermen.

Latitude (y_0)	Longitude (x_0)
09.082 N	79.320 E
09.132 N	79.317 E
09.182 N	79.313 E
09.232 N	79.302 E
09.280 N	79.280 E
09.325 N	79.260 E

Figure 3: Boundary database

The control unit, which consists of a microcontroller based circuit, is responsible for scheduling the capturing of the GPS signals, interpreting these signals and also checking for the boundary crossing. Furthermore, the control unit hardware contains a ROM (ROM1) which hosts the control program.

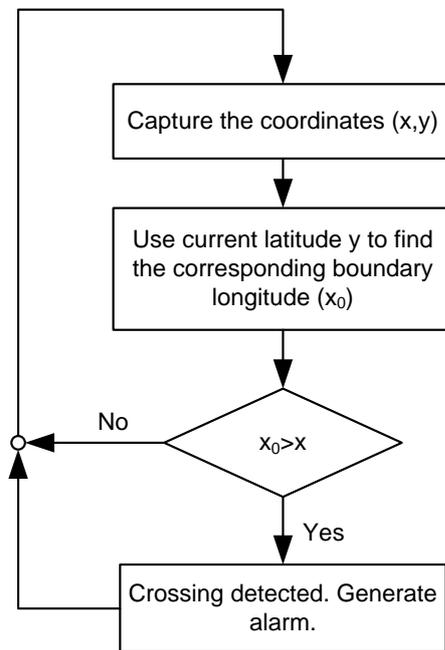


Figure 4: Geo-fencing algorithm

TEST RESULTS AND DISCUSSION

In order to test the accuracy and delay in the proposed system, a model system was implemented and was tested on land. Although blocking due to foliage was not completely absent at the selected test scenario, it closely resembled an unobstructed sea like environment.

A GPS receiver, SkyNav SKM53 with 30m accuracy was employed and a PIC16F877 microprocessor was selected for control. Further, a M2732 programmable ROM (PROM) was selected for storing the boundary data. First, a linear boundary was set and the data was burned to the ROM. Four tests were carried out. In the first, starting from the “within boundary” side, the system was very slowly taken to “outside the boundary”, perpendicular to the boundary and the alarm trigger point was observed. This reading was compared to the actual boundary to calculate the difference between the boundary and the point. We denote this difference as the distance error. It was seen that even at very low speeds, a 47m distance error was present on average. During real actual deployment, this error is acceptable in the scale of the maritime boundary. Second, the device was moved at different speeds from one side to the other, and the distance error was measured and the observations are listed in Table 1. A 64.35m error is also negligible in the maritime boundary scale.

Table 1: Average error vs. travelling speed

Speed (km/h)	Average distance error (m)
10	47.72
20	49.96
30	53.25
40	58.25
50	64.35

Furthermore, another test was carried out to check and compare the position of the system when the alarm indication appears for the existing and proposed systems. It was observed that with the proposed algorithm, 99.2% of the time the boat is notified before an actual boundary crossing, whereas only 58% of the time alarm is notified before a boundary crossing in the existing system.

On the other hand, the direction of the boat’s movement with respect to the boundary affects the accuracy. A fourth test was carried out selecting the angle between the boat’s movement and the boundary, randomly from $(0^{\circ}, 90^{\circ}]$ and observing the number of times notification occurred before an actual boundary crossing. It was observed that 99.6% of the time, notification occurred before a boundary crossing. Due to the use of the concept of the virtual boundary, in 44% of the cases, an actual boundary crossing happened after more than 300seconds from the notification. However, this is acceptable as the boat is still within 2km from the boundary and accompanies a risk of crossing the boundary.

CONCLUSIONS AND FUTURE WORK

This paper proposes a maritime boundary geo-fencing system where the key contribution is the use of a virtual boundary which improves the accuracy of timely notification. With its special design, it also consumes less battery power and maintains the distance error at an acceptable level.

This system can be further improved by adding a graphical display to the system or by providing an interface to link the system to a smart phone. Moreover, a feature can be included which conveys information of a crossing to the shore using the boat’s common communication equipments so that the necessary action can be taken.

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DESIGN OF AN IMPROVED ELEPHANT TRACKING SYSTEM

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INTRODUCTION

Elephas maximus maximus, the Sri Lankan elephant is a native mammal which has been an icon of Sri Lanka over centuries. Domesticated elephants have carried much of the heavy labour workload in ancient constructions when heavy machinery was not available. The elephant also plays an important role in both Buddhist and Hindu cultures. However, both domesticated and wild elephant populations have decreased dramatically over the past 50 years. Hence since 1986, the Sri Lankan elephant has been named as an endangered subspecies. Loss of habitat due to deforestation, deaths due to the human elephant conflict and also hunting for tusks have reduced the elephant population by more than half. Today, less than 6000 elephants roam in Sri Lankan jungles.

Government and non-governmental organizations (NGOs) have realized the need to protect this majestic giant and have taken many measures. In this protection process, monitoring of elephants is very important where it allows tracking the movement of elephant herds. This in turn allows warning when elephants have crossed the boundaries and reached the farmlands or villages. Thus the human-elephant conflicts are minimized. At the same time, elephants are frequently threatened by the train. This monitoring helps to understand the elephants' routes and hence special care can be taken by the train drivers.

There are many electronic elephant tracking systems available in the world where most of them are radio collar based and transmit very high frequency (VHF) radio beacons. With a Yaggi antenna, trackers go in the field and are capable of receiving the beacons within a radius of approximately 3km from the elephant (Tchamba *et al.*, 1995). However, this approach involves a considerable amount of effort and risk as the tracker has to physically go in to the elephant territory. Another approach is where a global positioning system (GPS) receiver based elephant collar captures the position coordinates and transmits the same via a global system for mobile communication (GSM) link to a remote location (Alanti *et al.*, 2000 & Quaglietta *et al.*, 2012 & Savannah Tracking, 2013). The major drawback of this system is that it requires a GSM coverage which is not present in more than 50% of the elephant habitats of Sri Lanka. To overcome the issue, a satellite based tracking system has also been introduced (Verlinden & Gavorv, 1998). All these systems operate in a point-to-point topology. Thus, to avoid the high cost involved with many links, a limited number of collars have been fixed to a few elephants in the herd. Hence these systems are more concerned on herd monitoring. However, the behavior/movements of individual elephants within the herd is also important to be monitored which is impossible with the available systems. In this paper, we propose a GPS receiver and GSM link based remote tracking system equipped with a Zigbee network to facilitate monitoring each individual elephant in the herd.

METHODOLOGY

The proposed radio collar system operates on a star topology, where a large elephant is fixed with a central monitor node collar which collects the position information from other collars and communicates the information to a remote monitoring location via a GSM link (Figure 1). Each individual collar is equipped with a GPS receiver and a Zigbee (Safaric, 2006) transmitter which captures the GPS coordinates of the elephant's position and transmits them to the central collar, respectively (Figure 2). The central node collar too consists of a GPS

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receiver for monitoring the same elephant’s location and also a Zigbee module for receiving the information from the other collars. Furthermore, the central collar has a GSM module to convey the collected information to the remote location. The controlling of the operation at each collar and also at the central station is carried out by microcontroller based circuits.

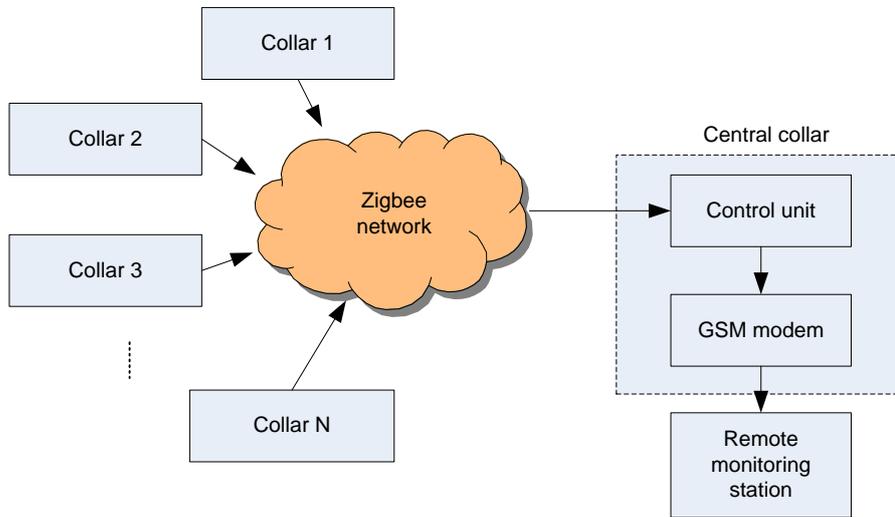


Figure 1: Block diagram of the proposed system

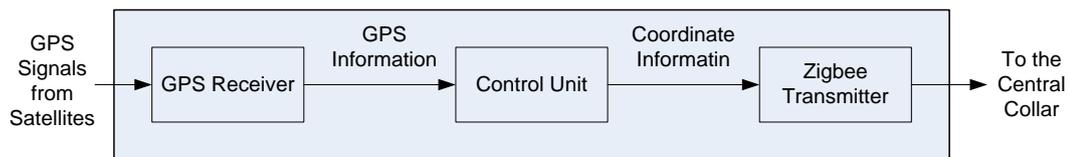


Figure 2: Block diagram of the proposed elephant collar

When the collars consisting of the tracking system are fixed to the elephants, it is almost impossible to replace the battery, hence a special battery with a longer life is used for powering the units and also a sleep-wake up mechanism is used to save power. The collars wake up every 15 minutes, capture GPS information and compare the reading to the previous reading. If the reading designates a point at least 100m (equivalent to a change in the third decimal point in GPS coordinates) away from the previous, then transmits the captured GPS information to the central node together with the unique collar identification number. This conditional transmission is also a vital power saving mechanism introduced in to the Zigbee sensor network. At the same time, relays / central collar listen in a 2 seconds window and compile all the received information to a single frame with the individual collar identification number tags and relays the information via the GSM link to the monitoring station. At the monitoring station, a Visual Basic 6.0 coded software interface displays the locations of the elephants in a map (Figure 3). Moreover, all the elephant collars are perfectly synchronized within the 2 seconds time slot to avoid collisions between the information of different transmitters.

It is a common incident that the GSM mobile coverage is not present in a considerable fraction of the elephant habitats. Therefore, the central collar unit is having a capability to store the information frames and forward them when the mobile coverage becomes available with the roaming elephant’s movement.

TEST RESULTS AND DISCUSSION

In order to test the accuracy of the proposed tracking system, a prototype system consisting of two collars and a central collar together with the monitoring station software was

implemented with a Fastrax UP501 GPS receiver (Fastrax, 2010), PIC16F252 microcontroller and SIMCOM 20300 GSM modem (Texas Instruments, 2012). A test was carried out at the university premises and the received coordinates from the tracking system were compared to the actual position coordinates which were taken from the Google maps. Moreover, the test was repeated for different distances between the end collar and the central station. Note that even though the selected test terrain was not having the same foliage density as in a real elephant habitat, it could adequately approximate a real habitat for testing purposes. Results are as shown in Table 1 where the readings corresponding to the distances up to 50m were communicated directly from the detected node to the central collar while the distances beyond 50m needed a relay collar for communication. It is clear that the difference or the position error is accurate to the third decimal point irrespective of the distance between the two collars and also independent of the use of the relay, which is adequate in real time elephant tracking requirements.

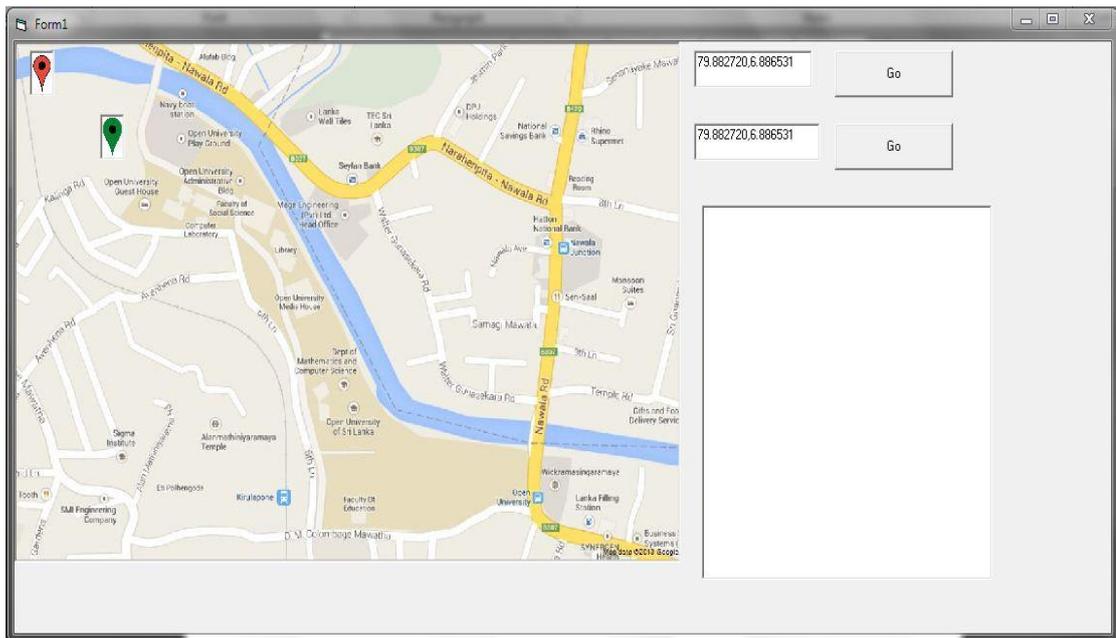


Figure 3: Monitoring interface

Table1: Comparison of tracked positions and the actual positions

Distance from the central collar (m)	Detected position		Actual position	
	Longitude	Latitude	Longitude	Latitude
5	79.8900833	6.8992171	79.8899711	6.8989801
10	79.8900833	6.8992171	79.8899680	6.8989769
15	79.8900833	6.8992171	79.8899654	6.8989771
20	79.8900833	6.8992171	79.8899635	6.8989745
30	79.8900833	6.8992171	79.8899523	6.8989656
40	79.8900833	6.8992171	79.8899464	6.8989561
50	79.8900833	6.8992171	79.8899363	6.8989450
60	79.8900833	6.8992171	79.8899205	6.8989371
70	79.8900833	6.8992171	79.8899050	6.8989285
80	79.8897111	6.8984772	79.8898722	6.8989100

CONCLUSIONS

This paper has proposed an improved elephant tracking system which addresses the shortcomings of many existing elephant tracking systems. The key feature here is that rather than monitoring each animal separately, the collars fixed to all individual elephants are monitored as a group where the information is captured together. This reduces power consumption; thus increasing the battery life time considerably. At the same time, the proposed system is highly scalable and of low cost.

The requirement to store data in the absence of mobile coverage is a considerable burden for the power saving process. If a satellite based link is employed, it would be able to capture and transmit the data immediately which would relieve the storage requirement.

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MULTIPURPOSE PULSE OXIMETER: OXYGEN SATURATION, BODY TEMPERATURE AND HEART RATE COUNTING METER

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INTRODUCTION

Medical devices can be categorized into two categories viz invasive and non-invasive methods. The invasive method needs a medical device to be inserted into the patient's body to investigate or carry out treatment on the patient. However, the non-invasive method is a way to check the health condition from the outside of the body. There is a huge market for non-invasive methods of measurement of the vital signs. The objective of this project is to design and implement a reliable, cheap, low powered, non-intrusive, and accurate system that can be worn on a regular basis and monitor the vital signs and displays the output on a doctor's cell phone. This data is easily accessible to the physician later (Mohammad, 2012).

The proposed design specifically deals with the signal conditioning and data acquisition of three vital signs: heart rate, oxygen saturation, and body temperature. The meter which gives these values together can be called a 'multipurpose pulse oximeter (MPPO)'. The most important clinical parameters in the evaluation of a critically ill patient are the pulse rate, oxygen saturation, temperature, blood pressure and respiratory rate. Monitoring and maintenance of these vital parameters during the first hour of trauma ('golden hour') or critical illness largely predicts the patient's overall outcome (William, 2006).

The currently available equipment for these monitoring devices are expensive, limiting their availability in most of the health care centers in Sri Lanka. The new design provides an easy way to assess the patient's vital parameters during the 'golden hour' and during the transfer period.

SYSTEM DESIGN AND METHODOLOGY

The multipurpose pulse oximeter consists of several hardware units as shown in Figure 1.

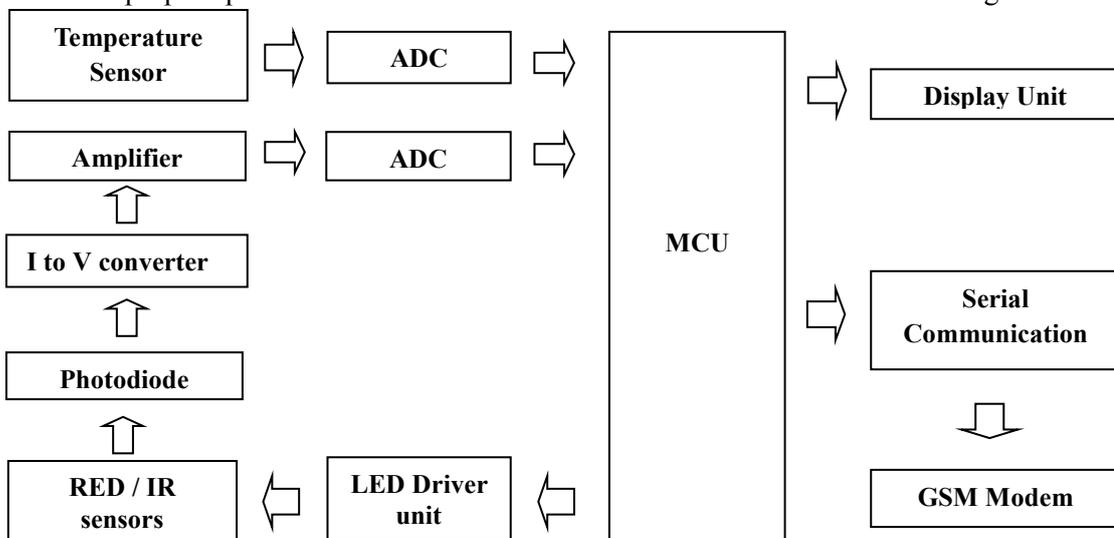


Figure 1: Block diagram of the MPPO system

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The MPPO can be divided into two units as measuring unit and sending unit. The temperature sensor (LM35) senses the body temperature and sends the analog value into the microcontroller (16F877A). The LED sensor unit consists of IR (LTR-4206) and RED (BL-S5131) sensors to emit IR and RED signals. The receiving side is equipped with a photodiode (BPW34). When the LEDs emit light, one by one photo detector produces current linearly proportional to the intensity of the light striking it. Then the current is converted to voltage, filtered DC values and noises and amplified. The analog value is fed to the microcontroller's ADC port.

Then the calculations are done at the microcontroller and the values are displayed on MPPO through liquid crystal display (JHD162A). Further the calculated values are sent through the interfacing circuit (MAX232) and GSM modem (SIM 300) to the on call doctor.

Body temperature measurement

The temperature sensor (**LM35**) is installed to measure the body temperature.

1. The output voltage from the sensor is converted to a 10-bit digital number ($2^{10} \approx 1000$) using the internal ADC of the PIC16F877A.

2. The resolution of ADC is $1/1024-1 = 0.000977V/Count$. Therefore, the digital output corresponding to any input voltage $V_{in} = V_{in} / 0.000977$.

Eg: Surrounding temperature is $26.4^\circ C$. Then output ADC, $0.264/0.000977 = 270$

3. By reversing this process, for 270 from ADC the temperature = $270 * 0.000977 (V/Count) / 0.01 (V/^\circ C) = 26.4^\circ C$.

Oxygen saturation (SpO_2) measurement

Red light emitting diode (**LTL-4266N**) and infrared light emitting diode (**LTR-4206**) are used to transmit the light and the phototransistor (**BPW34**) works as a receiver. When the LED's emit light, one by one photo detector produces current linearly proportional to the intensity of light striking it. It produces current linearly proportional to the intensity of light striking it. The hemoglobin in blood will absorb the light and pass through the finger.

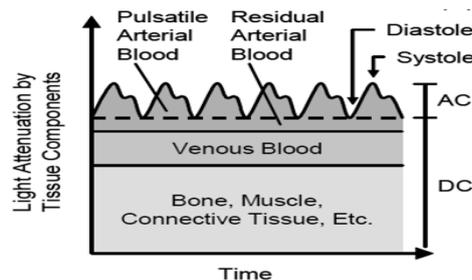


Figure 2: Expected output of the pulse oximeter (William, 2006)

Using Beer-Lambert's law and this absorbance properties of blood, the following equation has been developed to calculate oxygen saturation (SpO_2).

$$SpO_2 = \frac{(a_{Hbr} - a_{Hbir}R)}{(a_{Hbr} - a_{Hbo2r}) + (a_{Hbo2ir} - a_{Hbir})R}$$

Where

- a_{Hbr} Absorption coefficient of Red light in de-oxygenated hemoglobin
- a_{Hbir} Absorption coefficient of Infra-Red light in de-oxygenated hemoglobin
- a_{Hbo2r} Absorption coefficient of Red light in oxygenated hemoglobin
- a_{Hbo2ir} Absorption coefficient of Infra-Red light in oxygenated hemoglobin
- R Ratio of the output intensity

$$R = \frac{\ln \left(\frac{V_{max}}{V_{min}} \right)_{red}}{\ln \left(\frac{V_{max}}{V_{min}} \right)_{infrared}}$$

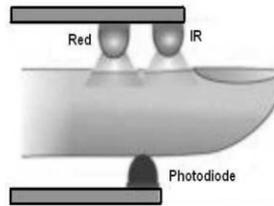


Figure 3: Schematic representation of SpO₂ sensor (Erica, 2010)

R is calculated in terms of voltage, not intensity. A ratio R comparing the two voltages at red and infrared wavelengths are given below.

$$SpO_2 = \frac{0.81 - 0.18R}{0.73 + 0.11R}$$

$(V_{max})_{Red}$ Red light voltage exiting through the finger during systole

$(V_{min})_{Red}$ Red light voltage exiting through the finger during diastole.

Table 1: Absorption coefficient table

Light (wavelength)	Absorption coefficient of Hb <i>L mmol⁻¹cm⁻¹</i>	Absorption coefficient of HbO ₂ <i>L mmol⁻¹cm⁻¹</i>
Red - 640nm	0.81	0.08
IR - 960nm	0.18	0.29

Using the standard values given in the Table 1 and using the above equations the oxygen saturation (*SpO₂*) is calculated.

Heart rate measurement

Heart rate is a byproduct of the signal acquired from the output of the photo-detector. Fig.02 shows the distance between two peaks of the output representing one cardiac cycle. If the time required in one cardiac cycle is “T” seconds (distance between the two peaks) then,

$$Heart\ rate = \frac{60}{T} \text{ beats per minute}$$

Viewing and sending the data via SMS

The measured three parameters are shown on the LCD display (**JHD162A**) and sends to the doctor via SMS through the GSM modem (**SIM 300**).

RESULTS AND DISCUSSION

To test the accuracy of the designed multipurpose pulse oximeter (MPPO)the results were compared with standard equipment.

Body temperature test

Table 2: Body temperature testing results

Patient	Hospital’s Thermometer value	MPPO reading
Patient 1	39 ⁰ C	39 ⁰ C
Patient 2	41 ⁰ C	42 ⁰ C
Patient 3	37 ⁰ C	37 ⁰ C

Oxygen saturation (SpO₂) test

Table 3: SpO₂ testing results

Patient	Hospital's SpO ₂ value	MPPO reading
Patient 1	100%	99%
Patient 2	100%	100%
Patient 3	99%	99%

Heart rate test

Table 4: Heart rate testing results

Patient	Doctor's HB value	MPPO reading
Patient 1	78bpm	78bpm
Patient 2	102bpm	98bpm
Patient 3	68bpm	68bpm

The authors could not test the equipment for oxygen saturation with the low SpO₂ values as then the patients were in critical when this happened. But for the other values MPPO provides a nearly accurate value. Further the authors could not test the equipment with a large no of patients as the patients were not medically fit.

CONCLUSIONS

This paper presents hardware and software designs of the multipurpose pulse oximeter (MPPO) which provides a low cost and secure meter which calculates and sends the heart rate, body temperature and oxygen saturation to the on call doctor. The use of a PIC microcontroller, GSM modem, sensors and LCD provide exciting possibilities. However as far as the industrial applications are concerned this can be viewed as a low cost, customized wireless remote monitoring system. Thus this solution can be customized to suit any other industrial applications. The use of GSM technology is provided to be controlled remotely and is cost-effective as compared to the existing systems. This MPPO can be modified for two other vital parameters viz, blood pressure and respiration rate in the future.

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COMPARISON OF SOME DESIGN PROVISIONS OF BS 8110 AND EC2 CODES FOR THE DESIGN OF REINFORCED CONCRETE COLUMNS

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INTRODUCTION

In Sri Lanka, BS 8110 is the code of design for concrete structures. BS 8110 produced by the British Standard Institution (BSI), offers guidance for reinforced concrete design within the United Kingdom and to most of the Commonwealth countries (Bond et al, 2006, Hagsten & Hestbech, 2002). In the year 2004, the European committee for standardization (CEN), published a final version of EN 1992-1 (called Eurocode 2 or EC2) for the design of concrete structures. One of the main objectives of the Eurocodes is to improve the competitiveness of the European construction industry. Eurocode 2 is expected to be used in parallel with the current code for a few years and ultimately replace the old code for concrete building design in the relevant countries (Mose and Brooker, 2007). BSI and other standards organizations in Europe have realized that local requirements also need to be considered. Each member country of the union has produced its own National Annex in which local requirements are specified (Bungey et al, 2007).

One of the expected goals of usage of EC 2 was to effectively replace the current British Standards as the primary basis for designing of concrete buildings and civil engineering structures in the UK by year 2011 (Draycott & Bullman, 2009). In this paper, an attempt is made to summarize the differences between BS8110 and EC 2 for the design of columns.

COLUMN DESIGN

Comparison between different codes

It is obvious that there are differences between these two codes in design philosophy. The significant differences between EC2 and BS 8110 are identified and explained as below.

Stress block

In EC 2, similar to BS8110, the rectangular stress block used for the design of beams can also be used for columns.

Effective length

Effective length has a direct influence in the load carrying capacity of the slender columns. Table 1a summarizes the differences between two codes in effective lengths used.

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Table 1a: Determination of effective length

	In BS8110	In EC2
Effective length	$l_e = \beta l_0$	$l_e = \beta l$
For braced	β from Table 3.19	$\beta = 0.5 \sqrt{\left(1 + \frac{k_1}{0.45 + k_1}\right) \left(1 + \frac{k_2}{0.45 + k_2}\right)}$
For unbraced	β from Table 3.20	$\beta = \max \left\{ \sqrt{1 + 10 \frac{k_1 \times k_2}{k_1 + k_2}}, \left(1 + \frac{k_1}{1 + k_1}\right) \left(1 + \frac{k_2}{1 + k_2}\right) \right\}$
Where:-	l_e = effective length l_0 = clear height β = factor get from table	l_e = effective length l = clear height k_1, k_2 = the relative flexibilities of rotational restraints at ends 1 and 2

Table 1b: Classification of columns

	In BS8110	In EC2
Short Column	braced	$\lambda < 15$
	unbraced	$\lambda < 10$
Slender Column	braced	$\lambda > 15$
	unbraced	$\lambda > 10$

Slenderness ratio is an important parameter in column design, which decides whether the column capacity is predominantly influenced by buckling. In BS 8110 slenderness ratio is calculated based on l_{ex}/h or l_{ey}/b . where l_{ex}, l_{ey} are effective lengths of column and h, b are dimensions of the column. However, in EC2 it is based on l_0/r and slenderness limit. Where l_0, r are effective length and radius of gyration respectively (Table 1b).

Slenderness ratio

In EC 2 there is a detailed procedure to determine slenderness limit (λ_{lim}) for column classification. Determination of slenderness limit is given below.

$$\lambda_{lim} = 20.A.B.C/\sqrt{n} \quad \{Eq. 1\}$$

Where:

$$A = 1/(1 + 0.2\Phi_{ef}) \quad \Phi_{ef} \text{ is the effective creep ratio (if } \Phi_{ef} \text{ is unknown, } A = 0.7 \text{ may be used)}$$

$$B = \sqrt{1 + 2\omega} \quad \omega = A_s f_{yd} / (A_c f_{cd}) \quad (\text{if } \omega \text{ is not known, } B = 1.1 \text{ may be used)}$$

$$C = 1.7 - r_m \quad r_m = M_{01} / M_{02} \quad M_{01}, M_{02} \text{ are first order end moments, } |M_{01}| \leq |M_{02}|$$

(if r_m is unknown, $C = 0.7$ may be used)

$$n = N_{ed} / (A_c f_{cd}) \quad N_{ed} = \text{applied design load and } f_{cd} = \text{Concrete strength}$$

It should also be noted that the slenderness limit (λ_{lim}) in EC 2, is dependent on the applied design axial load among other parameters such as concrete creep, load sharing capacity between concrete & reinforcement and end moment ratio. By making λ_{lim} inversely proportional to the square root of the ratio of applied axial compressive stress to strength, EC 2 has accounted for the negative effect of axial stress intensity on stability.

Determination of the design moment and deflection in a slender column.

In slender column design, the design moment and second order eccentricity calculation methodologies in BS 8110 and EC2 are different. Those differences are shown in Table 2.

Table 2: Determination of design moment

	In BS 8110	In EC2
Design moment	Maximum of $\{M_2, (M_1 + M_{add}), (M_1 + M_{add}/2), e_{min} N\}$	$N_{ed}(e_0 + e_1 + e_2)$
Deflection	$e_{11} = \beta_a k_1 h$ $\beta_a = (l_e/r)^2 / 2000$	$e_2 = (K_2 K_1 f_{cd} (l_e/d)^2) / (0.45 \pi^2 E)$

Where:-

- M_i -Initial design ultimate moment
- M_{add} -Additional design ultimate moment
- e_0 - Equivalent first order eccentricity
- e_a - Accidental eccentricity

e_2 - Second-order eccentricity
 K_r - Reduction factor
 K_ϕ - Creep ratio factor

Determination of accidental eccentricity (e_a) $e_a = v(l_o/2)$
 Where:- $v = 1/200$
 l_o – Effective length

Determination of the reduction factor (K_r) $K_r = (N_{uz} - N)/(N_{uz} - N_{bal})$
 Where:- N_{uz} - Axial load capacity of the column
 N - Ultimate axial load
 N_{bal} - Axial load at balanced condition

The calculation of N_{bal} is also different in both codes as;

$$N_{bal} = 0.25f_{cu}bd \quad (\text{BS 8110})$$

$$N_{bal} = 0.29f_{ck}A_c \quad (\text{EC 2})$$

Vertical reinforcement for columns

The maximum and minimum amounts of vertical reinforcement permitted by each code are decided by the geometrical property of the cross section. The maximum and minimum amounts of vertical reinforcement are given below in Tables 3a & 3b.

Table 3a: Maximum amount of vertical reinforcement

BS 8110	EC 2
6% of A_c (10% at laps)	4% of A_c (8% at laps)

Table 3b: Minimum amount of vertical reinforcement

BS 8110	EC 2
$A_{s,min} = 0.004A_c$	$A_{s,min} = 0.1N_{Ed}/f_{yd} > 0.002A_c$

EVALUATION OF THE DIFFERENCES

According to Euler theory there are four distinguished end conditions. However, the clear boundaries of the differences are difficult to distinguish in the real world. Therefore, both codes have correctly addressed this issue by providing intermediate values. If the coefficient of the effective length for theoretical pinned condition is considered as the upper boundary, the coefficient of the effective length for the theoretical fixed condition will be the lower boundary.

In using BS 8110 the minimum value of β that can be derived is 0.75. This value is an intermediate value in comparison to Euler values (pinned 1 and fixed 0.5). However, by using EC 2 the minimum value of 0.5 can be derived. EC2 suggests that the fixed condition can be really achieved in the field. It can be explicitly shown that this situation can be achieved in the field. One of the possible ways is setting k_1 and k_2 to zero. This situation is possible by having a negligible column stiffness compared to the beam stiffness as the k_1 and k_2 are calculated by taking the ratio of column stiffness to the beam stiffness. By increasing the beam width and depth drastically compared to column, the fixed condition can be achieved. In BS 8110 the minimum value is 0.75 which is 50% higher than the EC2 value.

In order to get the pinned end condition β should be equal to 1.

$$\beta = 0.5 \sqrt{\left(1 + \frac{k_1}{0.45 + k_1}\right) \left(1 + \frac{k_2}{0.45 + k_2}\right)} = 1$$

i.e

$$\sqrt{\left(1 + \frac{k_1}{0.45 + k_1}\right) \left(1 + \frac{k_2}{0.45 + k_2}\right)} = 2 \quad \{\text{Eq. 2}\}$$

Considering the symmetrical arrangement (both in the upper floor and lower floor) as the starting point,

Eq. 2 yields, $\left(1 + \frac{k}{0.45 + k}\right) = 2 \quad \{\text{Eq. 3}\}$

Equation 3 is mathematically true only when $k \rightarrow \infty$. This implies that Column stiffness is significantly higher (order of millions higher) than the beam stiffness which is practically very rare. Therefore, EC 2 does not converge to a pinned condition. However, BS 8110 gives pinned condition, when condition 3 is met as in Table 9.2.

Determination of slenderness ratio is more detailed in EC 2 compared to BS 8110. Observing the behavior of limiting slenderness ratio, it can be noticed that the slenderness ratio of EC 2 can be increased by maximizing the Eq. 1. In order to maximize the equation A, B and C should have their maximum values together with the minimum value for n. It is straightforward to maximize A, B and C and their values are 1, 1 and 1.7 respectively. However, minimizing n is not straightforward as it involves the design load. The trivial solution is minimizing the design load which is equal to zero. However, this solution has practically no importance. Therefore, the trivial solution is neglected as the solution does not provide any valuable output. When the parameter n becomes less than 1.0, limiting slenderness will be always greater than 20. This value is approximately 30% higher than the BS 8110 limiting slenderness value. However, n will be less than one in most of the real situations as the load is shared by concrete and steel in a column. Therefore, it is reasonable to argue that the limiting slenderness is greater than 20 if A, B and C have their maximum values.

Comparison of Normal load (N)- Moment (M) interaction chart in column design

Interaction charts are used to determine the reinforcement areas in column design when axial load and bending moment are simultaneously acting. The chart is drawn for a particular grade of concrete and a particular characteristic strength of reinforcement. Figure 1 illustrates the difference between charts from BS 8110 and EC 2.

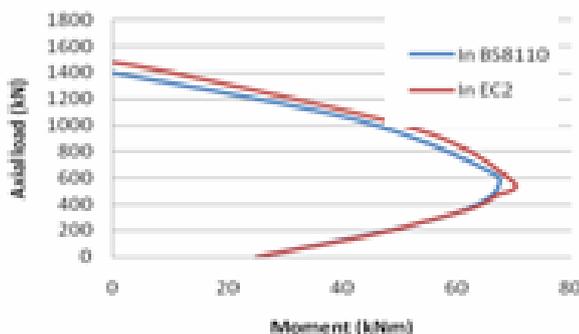


Figure 1 – Column Interaction Diagrams

For comparison of the balanced condition with two codes, following parameters are used. Column size - 300 x 300 mm, Concrete grade- C25, and Nominal cover - 20 mm, Main bar - 4T12, Transverse link - 6 mm. The balancing point, where the steel strain and concrete strain is same, occurs at the normal load of 600 kN and 65 kNm according to BS 8110, with 550 kN and 70 kNm according EC 2.

CONCLUSIONS

For determining the effective length, BS8110 provides tables and expressions as well as values of β with assessment of the end conditions that are appropriate. But the EC 2 procedure appears more complicated, as an assessment needs to be made of the relative flexibilities of the rotational restraints at each end of the column. According to EC 2, though different end fixities could be obtained, pinned condition will not be attainable.

For determining slenderness status of a column, BS8110 gives simple guidance through fixed limits. However, in EC 2, a more complex approach dependant on several parameters is presented which does not have much practical value and is prone to interpretation and calculation errors.

According to the M-N diagram at the balance point marginal decrease of normal load (less than 8%) was observed in EC 2 and 15% increase of the moment was observed indicating that would over-estimate flexural capacity.

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USE OF DUNE SAND AS AN ALTERNATIVE FINE AGGREGATE IN CONCRETE AND MORTAR

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INTRODUCTION

River sand is the most widely used fine aggregate in civil engineering constructions in Sri Lanka. Traditionally river sand is extracted from rivers and streams. In the Jaffna peninsula there are no rivers or streams flowing through the area. Sand deposits in rivers are depleting in Sri Lanka, especially in the Southern region, as the annual demand for sand is very high due to rapid increases in civil constructions. The total demand of sand in Jaffna is met by the supplies of sand from the Southern region. This has led to large scale sand mining in the southern part of the country. As a result, most river banks have been eroded. Therefore, it is necessary to minimize sand mining, which is hazardous to environment.

One way to minimize this problem is to introduce an alternative material to river sand, such as dune sand, offshore sand and land based sand etc. Several studies have been conducted on dune sand in different countries to identify its suitability for concrete (Alhozaimy et al, 2013, Al-Harthy et al, 2007, Guettala and Mezghiche, 2011). Dune sand is the most widely available form of sand in the northern part of Jaffna.

The estimated total quantity of the dune sand that can be mined is 18.38 million cubic meters (Dias et al, 1999). This article describes the suitability of dune sand and quarry dust as fine aggregate in concrete and mortar instead of using river sand as fine aggregate.

TEST PROGRAMME

Sri Lankan experience in mix design together with the UK method described by Department of Environment for concrete mix design in the UK was used for the preparation of concrete mixes (Dias et al, 2002). It was decided to carry out testing for grade 25 concrete as that is the most widely used concrete in building construction. The OPC content of concrete was kept close to 340 kg/m³ (Dias, 2003). The rest of the materials were determined according to the guidelines provided by the UK Department of Environment. The target slump of the mixes was 120-150 mm. Although the addition of an air entrainer is common in warm climates to improve the workability, it was decided not to use an air entrainer in the mix as the production cost will increase (Shetty, 2010). As the objective is to minimize sand use, the fine aggregate phase was replaced with dune sand and quarry dust.

Five different types of mixes were prepared by partially replacing quarry dust with varying percentages of dune sand namely 10% (M-1), 30% (M-2), 50% (M-3), 70% (M-4) and 100% (M-5). 100% (M-5) dune sand consisted of a mix that represents the maximum percentage that can be used in the mix design. Adjustments were not made in the determination of water content due to the addition of dune sand which is common in modified mix design methods (Dias et al, 2002) as the mixture of dune sand and quarry dust acts against each other with respect to the water demand (see discussion).

Table 1 illustrates the mix proportions adopted for the concrete testing. The dune sand percentages were varied from 10 to 100%.

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Table 1: Mix proportions (kg/m³) for grade 25 concrete

Sample/Results	M-5	M-4	M-3	M-2	M-1
Grade	25	25	25	25	25
Water/cement ratio	0.5	0.5	0.5	0.5	0.5
Cement content (kg/m ³)	341.66	341.66	341.66	341.66	341.66
Water content (kg/m ³)	170	170	170	170	170
Fine aggregate (kg/m ³)	726.7 (DS-726)	726.7 (DS-508)	726.7 (DS-363)	726.7 (DS-128)	726.7 (DS-73)
Coarse aggregate (kg/m ³)	1136.64	1136.64	1136.64	1136.64	1136.64

DS- Amount of dune sand

For mortar, the flow test and compressive strength test for cement block were performed and the mix proportions together with the measured values are presented in Table 2.

Compressive strength test

The compressive strength test was conducted according to BS 1881 for fifteen cubes pertaining to a batch. 150 x 150 x 150 mm cubes were cast for the compressive strength testing. All samples were cured after 24 hours. For each testing three cubes were tested. Compressive strength development was observed at 3, 7 and 28 days after casting. Early age strength is important in warm countries as thermal shrinkage cracks can cause damages in structures if the initial strength gain is low (Shetty, 2010). Such phenomenon is also common in concrete mixes with fly ash (Luo et al, 2013). Therefore, it was decided to measure the three-day strength after casting cubes to determine the early age strength.

Durability test

The durability test was carried out on specimens that had a size of 100 x 100 mm (diameter x height) and was cast in plastic moulds. The test was carried out for both concrete and mortar. Concrete durability was tested by using sorptivity (Dias, 2003). Sorptivity is an index of moisture transportation into unsaturated specimens. The experiment was carried out for 24 hours and the specimens were placed on sponges with the cast surface in a shallow tray of water.

Fresh state - Fluidity

The following tests were carried out for fresh stage properties of concrete.

Slump loss test for concrete

Slump test for concrete

Fluidity test for mortar

The fluidity test was carried out only for mortar. The slump test was performed according to BS 1881 and the flowability test was performed according to BS 1015.

RESULTS AND DISCUSSION

Fresh concrete properties

As the fresh stage properties slump, slump loss together with flowability experiments were carried out. The non agitated slump loss was carried out for 1 hour. The concrete used for the non agitated slump loss test was not returned to the concrete cube preparation. The highest slump value (180 mm) was demonstrated by the mix with 100% dune sand while the least

value (130 mm) of initial slump was demonstrated when the dune sand percentage was 10. The difference in slump values can be explained by considering the particle shape of dune sand. Due to the nature of formation of dune sand most particles possess a spherical shape. Therefore, the frictional force between particles becomes less and shows a higher flowability which is similar to ball bearing action (Nanayakkara, 2003). As a result, the mix of 100% dune sand exhibits the highest slump value. Arguing along that line, the least slump is given by the 100% quarry dust sample which has more angular particles and hence there are higher frictional forces between the particles. However, after 60 minutes (in the slump loss test) all the mixes gave similar slump values which indicate there was no impact from dune sand (Fig 1a).

The flow table values indicate that the addition of dune sand increases the flowability of mixes. A flow table value of 212.5 mm was demonstrated when the dune sand percentage of the mix was 100 (Table 2). This behaviour is also consistent with the explanation offered to the behavior of slump values.

Table 2: Flow table test results together with their mix proportion

Mix number	Dune sand % in mix	Quarry dust % in mix	X(mm)	Y(mm)	Flow value(mm)
1	100	0	230	200	215
4	70	30	150	150	150
6	50	50	140	140	140
8	30	70	125	143	134
10	10	90	120	120	120

Hardened state - Compressive strength of mortar

Figure 1b shows the compressive strength results of hardened concrete. Each value presented is the average of the three values of three samples for each mix type. The compressive strength is gradually increased with a dune sand percentage (Fig.1b). The highest compressive strength is recorded when the dune sand percentage of mix is equal to 50%. The strength variation indicates similar behavior in all three days (i.e 3, 7 and 28 days). Similar strength development can also be observed in mortar (Fig 1c). Compressive strength values of all mixes of 1:5 mortar satisfied the Sri Lankan standard (ICTAD specifications), which is greater than 5 N/mm². According to the results compressive strength of mortar is higher than 5 N/mm².

The marginal optimum point of the strength can be explained by considering the shape of the particles in the micro structure. As explained earlier dune sand contains more spherical particles. Although this helps for workability, micro level pores can be filled only by dune sand. Quarry dust has more angular shaped particles. These particles help to fill the micro pores to some extent. However, after increasing 50 % of quarry dust, angular particles dominate the micro structure reducing the workability, which affects the strength.

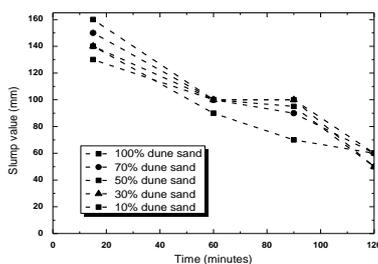


Figure 1a: The variation of slump loss

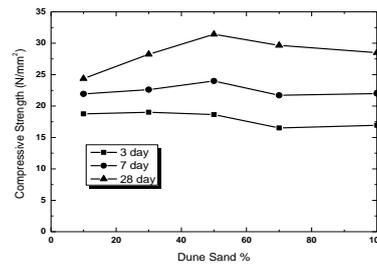


Figure 1b: The behaviour of compressive strength of concrete

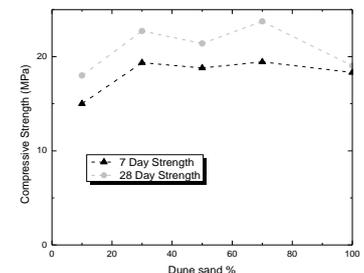


Figure 1c: The behaviour of compressive strength of mortar

Durability test

Figures 2a and 2b which represent the penetration depth change versus the square root of time demonstrate the approximate linear plot for each of the mixes (Fig 2a and 2b). According to figures 2a and 2b, the rate of water absorption for all mixes is less than 2×10^{-5} mm/ $\sqrt{\text{min}}$. However, the correlation coefficient (R) value for mixtures M5 and M4 are less than 0.98. All the other mixtures gave a correlation coefficient (R) that is greater than 0.98. The concrete produced with 50 % or above dune sand shows a clear difference of sorptivity both air cured (dry curing) and water cured. Increasing percentages of dune sand causes an increase in sorptivity in both air cured and water cured samples. However these values are marginally higher (less than 15%) than those that are produced by river sand (Dias, 2003).

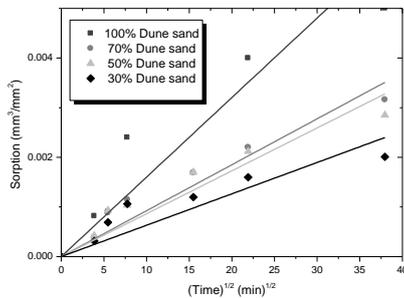


Figure 2a: Dry cured sorptivity values

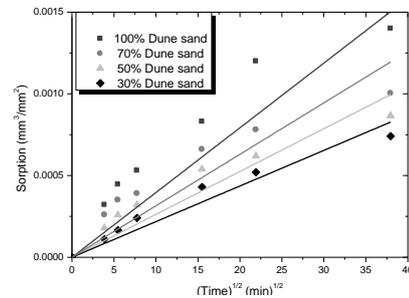


Figure 2b: Wet cured sorptivity variation

These phenomena can be explained considering the shape of dune sand. Circular shaped of dune sand causes opened pores at micro levels which cannot be filled. These micro levels pores help to conduct fluid. Therefore a higher percentage of dune sand causes the increment of sorptivity

CONCLUSIONS

This paper investigated the suitability of dune sand in concrete and mortar. Ball bearing action dominates the flow of dune sand mixed concrete. Marginal strength variation (less than 8%) occurs in the concrete when dune sand is used. The marginal strength variations are probably due to the combined effect of particle shape of dune sand and quarry dust. Mortar with dune sand satisfies the Sri Lankan strength requirement. The behavior of slump loss is same in all the mixtures. The drop of slump values after 2 hrs was approximately 60% for all the mixtures. The sorptivity parameter is closely related to the amount of dune sand. The highest sorptivity value was obtained when the dune sand percentage is 100.

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INVESTIGATION OF STRUCTURAL AND FOUNDATION FAILURES OF THE GODAKAWELA AGRARIAN SERVICES CENTRE BUILDING

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INTRODUCTION

The Agrarian Services Centre Building located at Godakawela in Rathnapura District is a single storey building constructed in 1976. At present, the building is completely abandoned due to propagation of wall cracks [Figure 1(a)], floor deformities [Figure 1 (b)] and wall deflections etc. A close observation indicated that some cracks appearing on the walls continued to the foundation and most of the cracks are wider than 10 mm. Further, it was also observed that there is hardly any system to drain off rain water from the vicinity of the building and in fact rain water accumulates within the premises aggravating the situation.

A cursory observation of the buildings in the surrounding area indicated that similar cracks in walls are common in most of the relatively old single storey buildings. It was suspected that the soil in the area consists of expansive clays.

Expansive soils shrink and swell when the moisture content changes from dry to moist and vice versa. Thus, shrinking and swelling can be reduced if the moisture content is kept stable. Major damage can be avoided if a few precautions are taken to ensure that the soil under the foundation does not experience excessive moisture changes (Thomas, 1998).



(a) Wall cracks

(b) Floor deformities

Figure 1: Cracks appearing in the building

METHODOLOGY

It was necessary to verify that the problematic soil present under the foundation of the building is in fact expansive soil. Plasticity index — the difference between liquid limit and plastic limit — is the most commonly used indicator of soil expansive behavior. The Atterberg limits, which include liquid limit (LL), plastic limit (PL), and plasticity index (PI), define moisture content boundaries between states of consistency in soils (Casagrande, 1948). Laboratory tests were conducted to determine Atterberg limits to classify the soil according to

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ASTM D2487. Also, the swell potential of the problematic soil was determined in the laboratory according to the method described in ASTM D 4546-03.

Further, using this as built data, since no construction drawings were available, the contact pressure exerted by the existing foundation of the single storey building was evaluated to compare with the swell pressure of problematic soil.

FIELD INVESTIGATIONS

Soil samples were collected from three test pits located very close to the strip foundation of the building. Pits were dug up to 1.5 m by using minor tools and hand auguring was done on the basis of each test pit to obtain more information on sub soils. Disturbed and undisturbed samples were collected to carry out the laboratory tests.

Subsurface exploration drilling and soil mineralogy tests were not carried out due to the budgetary constraints.

LABORATORY INVESTIGATIONS

Laboratory investigations were carried out at the Soil Laboratory of the Central Engineering Consultancy Bureau (CECB). Following tests were done on the collected samples to determine the required soil parameters.

- Natural water content
- Bulk density test
- Atterberg limits
- Specific gravity test
- Shrinkage limit test
- Swell index test
- Direct shear test

RESULTS AND DISCUSSION

Sub Surface Condition - Findings

Subsurface soil profiles, as described in Table 1, were identified by field and laboratory investigations. The foundation of the building is seated on Layer No. 2.

Table 1: Geotechnical properties of soils (Classified according to ASTM D2487 – 06)

Layer No.	Layer Description	Depth Range (m)	Unit Weight (kN/m ³)	Cohesion (kN/m ²)
1	Fine to coarse grained Clayey Sand (SC)	Ground – 0.85	18.1	10
2	Slightly gravelly Sandy Clay (CH)	0.85 – 1.50	16.5	11 - 14
3	Fine to medium Sandy Clay (CS)	Below 1.50	17.0	11

Results of Laboratory Tests

Results of the Atterberg limits tests conducted on the problematic soil samples collected from Layer 2 are plotted in the Plasticity Chart shown in Figure 2. Figure 2 shows that the LL of problematic soil varies from 44 to 62% and PI varies from 28 to 43%. Based on the classification proposed by Holts & Gibbs (1956), as shown in Table 2, soils having these ranges of LL and PI are classified as soils having “**high**” potential swell. Chen (1975) also

classified soils having liquid limit ranging from 40 – 60 as soils with “**high**” potential for expansion. This confirms that the problematic soil found at the site is a soil with a high potential swell.

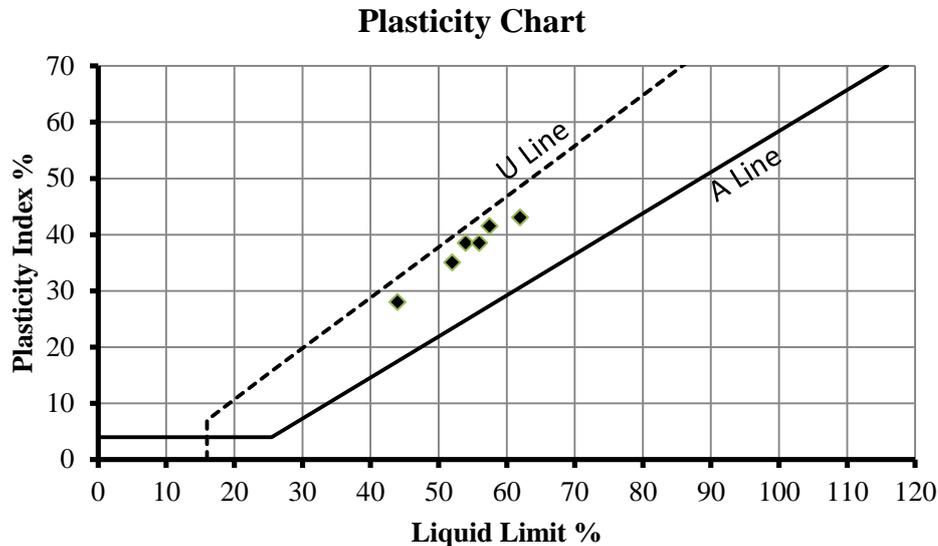


Figure 2: Results of Atterberg limits test on problematic soil

Table 2: Classification of potential swells (Holtz and Gibbs, 1956)

Classification of potential swell	Liquid Limit (LL) %	Plasticity Index (PI) %	Shrinkage Limit (SL) %
Low	20 – 35	< 18	> 15
Medium	35 – 50	15 – 28	10 – 15
High	50 – 70	25 – 41	7 – 12
Very high	> 70	> 35	< 11

Results of swell index test conducted according to the method described in ASTM D4546 – 03 (2003) indicated that the swell index of the problematic soil varies from 41 to 60 kN/m².

Single storey Agrarian Services Centre building consists of a Calicut tiled roof, 225 mm thick load bearing brick walls and a rubble masonry foundation. The depth of the foundation observed at site was 0.85 m below ground surface and the width of the rubble masonry foundation was taken as 0.45 m. The contact bearing pressure calculated using the above data is 41 kN/m². This is less than the “**swell pressure**” of the tested soil, defined in ASTM D4546 – 03 (2003) as the pressure which prevents the soil from swelling.

CONCLUSION/RECOMMENDATIONS

Seasonal changes in moisture content of soil due to wetting and drying results in substantial expansion and shrinkage in expansive soils. Being a single storey building, the contact pressure on soil exerted by the foundation is not sufficiently large to counter the swell pressure exerted by expansive soils and has resulted in foundation movements thus producing cracks in the walls of the building. Following recommendations can be made to make the abandoned building serviceable:

1. Isolate the strip foundation with a cut off wall (Wray, 1995) – Construct a concrete cut off wall along the pavement of the building to cut off seepage of water reducing the seasonal changes of moisture content of underlying expansive soils. It is advisable

- to waterproof the external face of the cut off wall before backfilling.
2. Improve drainage of water in the surrounding area (Wray, 1995) – Reduce infiltration of water adjacent to the building by constructing an impervious surface (concrete surfacing or precast cement sand tiles are recommended) and facilitate drainage of water by having a proper drainage system within the premises in order to avoid saturation due to high seepage during rainy season.
 3. Repair the hairline cracks of the wall – Structural integrity of the building is not affected by hairline cracks and by preventing occurrence of seasonal changes in moisture content of underlying expansive clay, re-appearance of these cracks can be prevented.
 4. Demolish the walls structurally damaged and re-construct – Where the cracks are very wide and complete separation of wall has occurred, demolish the wall and re-construct it.

Contact pressure exerted by single storey buildings is too small to counter the resulting swell pressure of expansive soil according to the experimental results. If sufficiently large contact pressures are applied, effect of swell pressure can be balanced or minimized. This can be achieved by having high structural loads by constructing at least two storey buildings. However, considering the small thickness and the shallow depth of the expansive soil layer the most economical solution for future constructions would be replacing the expansive soil layer completely with suitable well compacted material.

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CAPABILITY STUDY OF VERTICAL MOVEMENT AND EFFICIENT ATTACHMENT AND DETACHMENT MECHANISMS IN A WALL-CLIMBING ROBOT

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INTRODUCTION

A wall climbing robot is an autonomous leg robot, which climbs vertical surfaces using suction force mechanism and the moving arm mechanism. The wall-climbing robot uses suction as a means of sticking to the wall and uses vacuum pumps to provide sufficient pressure inside the vacuum cups, which are pressed against the wall. The robot controls the movement of its legs by using four stepper motors, which are located on the left and right side of the robot. The robot can move in four directions: forward, backward, left and right. The suction force is supplied by four vacuum pumps, which will turn on intermittently. There are a variety of applications in robotics for wall climbing operations that can increase efficiency, safety and reliability. These applications include inspection of concrete walls, to access the underside of bridges, the inspection large storage tanks in nuclear power plants and cleaning tall buildings, which are usually performed by humans. Wall climbing robots have the potential to provide a revolutionary step in doing risky tasks that are usually performed by humans. Currently, there is a big demand for automatic cleaning systems for the outside surfaces of buildings, such as window glass surfaces, due to modern architecture. Some customized window cleaning machines have already been installed for practical use in the field of building maintenance. However, almost all of them are mounted on the building from the beginning and are very expensive.

The objectives of this study is to conduct a capability study of the vertical movement and efficient attachment and detachment mechanisms of wall-climbing robots.

METHODOLOGY

We selected Degree Of Freedom (DOF) 1 for each leg of the wall-climbing robot. Past literature has found that the suitable DOF is 2. However, owing to the difficulties of contracting the mechanical structure of the robot's arms, we used one DOF to achieve the optimum capability of vertical movements of autonomous robots.

For the robot suction mechanism, we designed a robot with robust and efficient attachment and detachment mechanisms. The factors that have been considered in the development of the suction system for the robot are:

1. Ensure that all suction cups are parallel to the wall surface during the rotational motion of the legs.
2. Using high-vacuum level vacuum pumps so that the suction cups adhere to the surface of a ordinary wall building.

Figure 1 depicts the overall view of the robot. The upper part of Figure 1 shows the top view, while the bottom part of Figure 1 shows the side view of the robot.

The robot works with vacuum cups. It uses the principle of pressure difference of the atmospheric pressure and the inside pressure of the vacuum cup. The pressure difference makes the force of the robot hold on to the wall. Figures 2 and 3 show the force generated in

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the vacuum cup and the vertical surface.

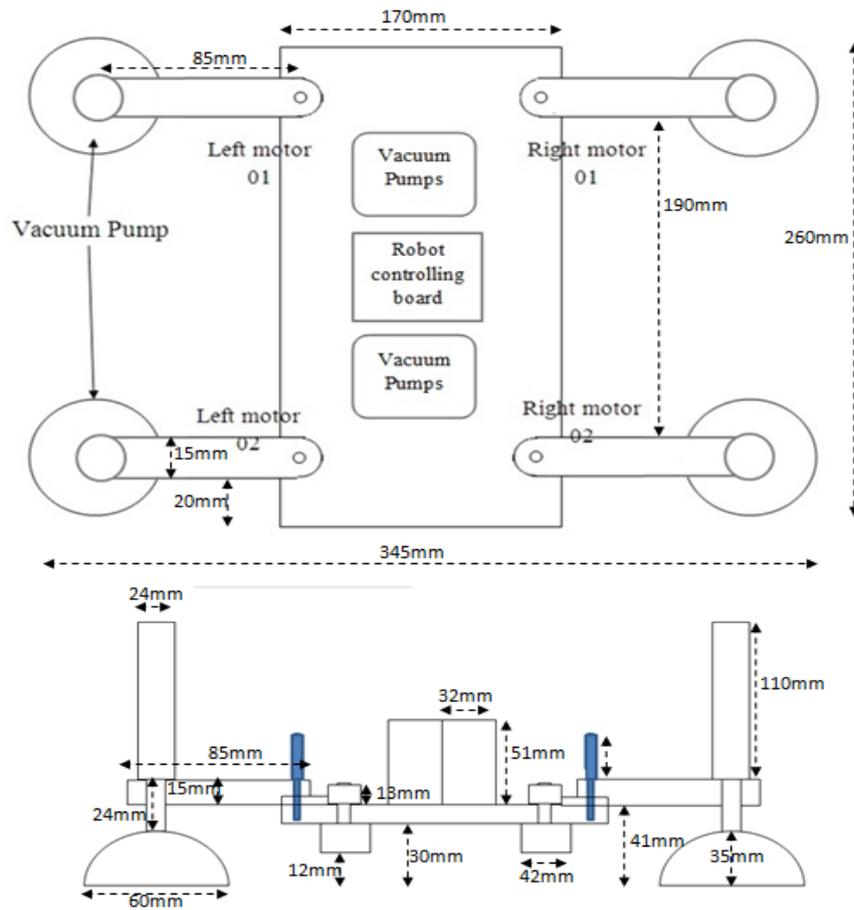


Figure 1: The overall top and side views of the system
Therefore, the force can be found as follows:

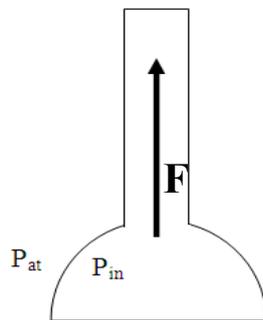


Figure 2: Force generate in Vacuum Cup

$$P_{at} - P_{in} = \frac{F}{A} \quad (1)$$

$$F = (P_{at} - P_{in})A \quad (2)$$

Where P_{at} = Atmospheric Pressure,
 P_{in} = Pressure inside Vacuum Cup,
 A = Area of Vacuum Cup

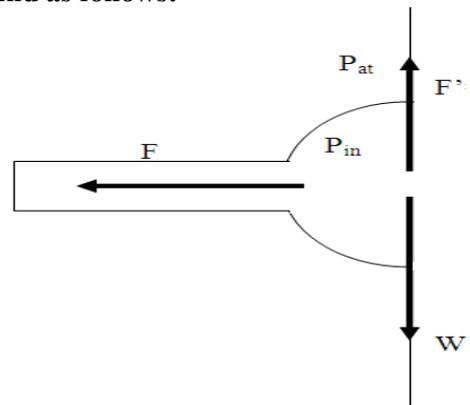


Figure 3: Force generation on vertical surfaces

$$F = F' \mu \quad (3)$$

$$W = F \quad (4)$$

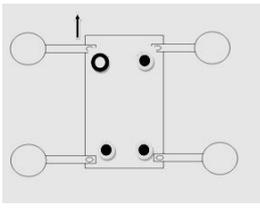
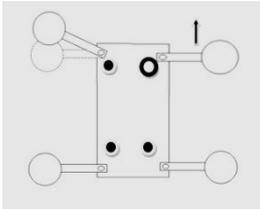
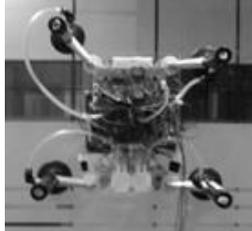
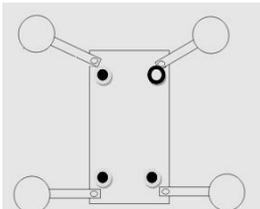
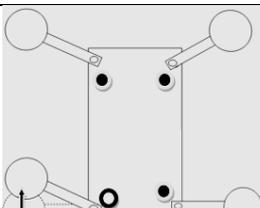
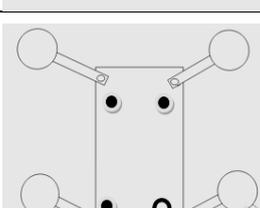
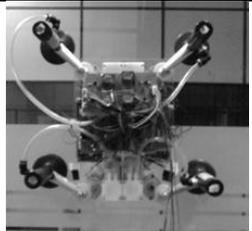
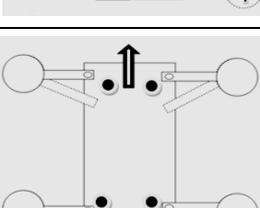
$$W = \mu(P_{at} - P_{in})A \quad (5)$$

Where F = Reaction Force, F' = Frictional Force, μ = Coefficient of Friction between Pad and Wall, it depends on the materials of Wall and pad

RESULTS AND DISCUSSION

The prototype model of the robot required 4 vacuum pumps and four stepper motors. The measured value for each stepper motor needs a 1.87A current when it is operating, and the measured value for each vacuum pump needs a 0.4A current. Therefore, the robot needs a 9.08A current. The computation showed that the maximum weight that can hold a 65k Pavacuum pump with a 60mm vacuum cup of the robot is about 40kg for $\mu = 1$. Table 1 depicts the test results of the study.

Table 1: Comparison of the results for each test case

Test Case Description	Expected results	Obtained Results	Accuracy (%)
This is the initial state of the robot. In this case, the robot obtained the expected result that was described in the methodology section.			100
First movement of the left-upper robot leg			90
Second movement of the left-upper robot leg			90
Third movement of the left-lower robot leg			90
Results of the fourth movement			90
Results of the fifth movement			95



Suction force connected



Suction force disconnected

There are six test experiments that have been successfully tested. After the fifth movement, the robot came to the initial state and moved 3cm to the front. The robot takes 4 seconds to complete a cycle (from the initial state to the initial state again). In the six test cases, as explained in Table 1, the robot achieved acceptable accuracy.

CONCLUSIONS/RECOMMENDATIONS

This study proposed and designed a wall-climbing robot for a capability study of vertical movement and efficient attachment and detachment techniques. The designed robot had one degree of freedom, so it is possible to move in a linear path, which can be considered one of the features of the system.

Suction cups and pumps operated efficiently, providing correct pressure as computed in equation 5 for the attachment and the detachment of the robot legs to the wall, while the DOF1 robot legs were controlled by the four stepper motors. It provided sufficient capability to achieve the objectives of the study with acceptable accuracy.

During the robot's movement on the wall, it was found that the robot must always retain the vacuum cups for holding. Also, this can be used only on smooth surfaces. It was unable to operate on irregular or uneven surfaces, as it was not possible to generate a suction force on irregular or uneven surfaces. This is a major disadvantage of suction force controlled robots. However, this is a better way of climbing walls when compared with existing other mechanisms.

It was found that a DOF of more than one is needed for smooth navigation, providing sufficient stability on uneven surfaces. It will also be required to consider using more than 4 legs for safety and navigation on uneven surfaces in this type of robot design.

It was observed that the vacuum pump became heated during the testing due to the high current passing through the pumps. It is recommended that the use of a PWM pump that is controlled with a current limiting facility would increase safety and stability of wall-climbing applications.

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USE OF WASTE COCONUT SHELLS AS SUBSTITUTE FOR COARSE AGGREGATE IN LIGHT-WEIGHT CONCRETE MIXES

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INTRODUCTION

Concrete is a premier construction material consisting of a natural aggregate, such as gravel/crushed rock as a coarse aggregate, sand as a fine aggregate, cement as a binding medium, water and admixtures. Usually, granite or granitic-gneiss rock is used as a coarse aggregate for concrete in Sri Lanka.

The coconut shell is a natural material that is available abundantly in Sri Lanka. Waste, generated by industrial and agricultural processes, has created disposal and management problems that pose serious issues of environmental pollution. In Sri Lanka, coconut shells are reused in many applications and some amounts of it are exported. However, the Coconut Development Authority statistics indicate that a considerable amount of coconut shells remain in the environment as waste (Coconut Development Authority, 2012). Therefore, the utilization of these materials in construction will be an important step to improve sustainability and eco-friendly construction. In addition to that, it will help to reduce the self-weight of concrete structures. This study will help to reduce other necessary ingredients in the production of concrete. The current study examines the suitability of the partial replacement of a coarse aggregate with coconut shells in the production of concrete.

METHODOLOGY

Coconut shell samples were collected, cleaned and prepared for testing. Particle size distribution tests (BS 812-103.1: 1985) were conducted for manually crushed coconut shell samples to calculate the amount of each size that should be mixed to obtain a well-graded aggregate sample. The physical properties of a coconut shell, its moisture content, water absorption, specific density, impact value, flakiness index and elongation index, were determined.

A concrete mix was prepared by using the British weigh batch method. The proportions used in the control sample of 1 m³ are shown in the table below.

Table 1: Quantities of the Materials

Constituent	Water	Cement	Fine Aggregates	Coarse Aggregates
Quantity (kg)	225	450	836	1064

Concrete specimens for different trial mixes, with different combinations of crushed coconut shells namely 0%, 4%, 8%, 12%, 16% and 20%, were cast. For each trial mix proportion, 6 cubes of 150x150x150mm for testing Compressive strength as per BS 5328-1997 and 4 cylinders of 100x200mm for testing splitting tensile strength as per ASTM C496-90 guidelines were cast. Workability was measured using the Slump test for a target slump of 60-180mm. A water absorption test was carried out according to ASTM C642-82.

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RESULTS AND DISCUSSION

Sieve Analysis

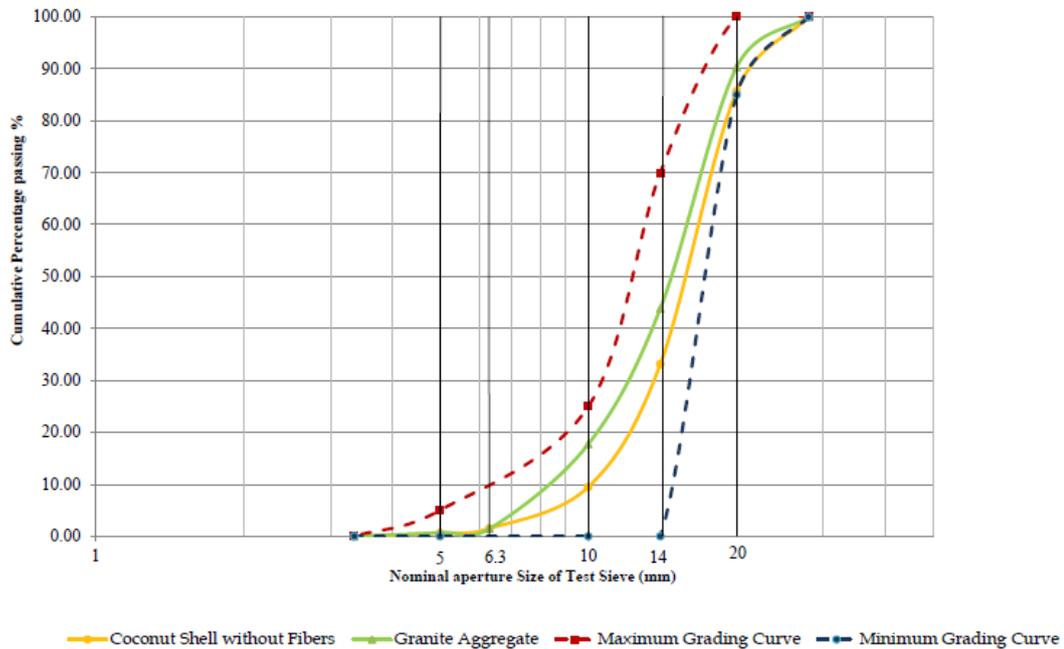


Figure 1: Grading curves of Coconut Shells & Conventional Coarse Aggregates Comparison with British Standard

The Gradation curve of a coconut shell falls within the recommended range for a coarse aggregate (BS 882). All tests were performed using aggregates from these well-graded coconut shell samples.

Physical properties of the Coconut Shells

Table 2: Physical properties of Conventional Coarse aggregate (granite) and coconut shell

Physical Properties	Testing Specification	Coarse aggregate	Coconut shell	Recommended value
Moisture Content dry (%)	BS812-109:1990	0.14	12.93	Depend on the Drying period of the aggregate
Moisture Content wet (%)	BS812-109:1990	0.14	11.45	
Specific Gravity	BS812:Part2:1995	2.73	1.31*	Normal weight aggregate 2.5-2.8
Water Absorption (%)	BS812:Part2:1995	0.49	26.05	Less than 3 BS 5337:1976
Aggregate Impact Value (%)	BS812:Part112	15	2.7	Maximum 30 % BS882:1983
Flakiness Index (%)	BS812:105.1:1995	15.69	99.19	Maximum 25 %
Elongation Index (%)	BS812:105.2:1990	58.54	50.56	Maximum 25 %

* The specific gravity of the coconut shell satisfies the value for a lightweight aggregate, which is less than 2 (BS 812-2)

Properties of other ingredients

- Water: Portable water was used for the production of concrete mixes
- Cement: Ordinary Portland cement was used and the cement strength class was 42.5
- Fine aggregates: River sand was used and the particle size was sieved through a 5mm sieve. The specific gravity of fine aggregate is 2.63.

Workability of Concrete

Considering normal concrete applications and the grade of concrete, a target slump is taken as 60-180mm for a concrete mix design (Neville, 1990). The variation of the slump with the replacement of a coconut shell aggregate is shown in Table 03. The results indicate that the slump tends to increase with the increment of coconut shell percentages, resulting in higher workability.

Table 3: Workability of Concrete (slump mm)

Coconut shell replacement (%)	0	4	8	12	16	20
Slump (mm)	90	120	160	160	165	170

Compressive Strength

The compressive strength variations, according to the replacement of coconut shells, are given in Figure 2.

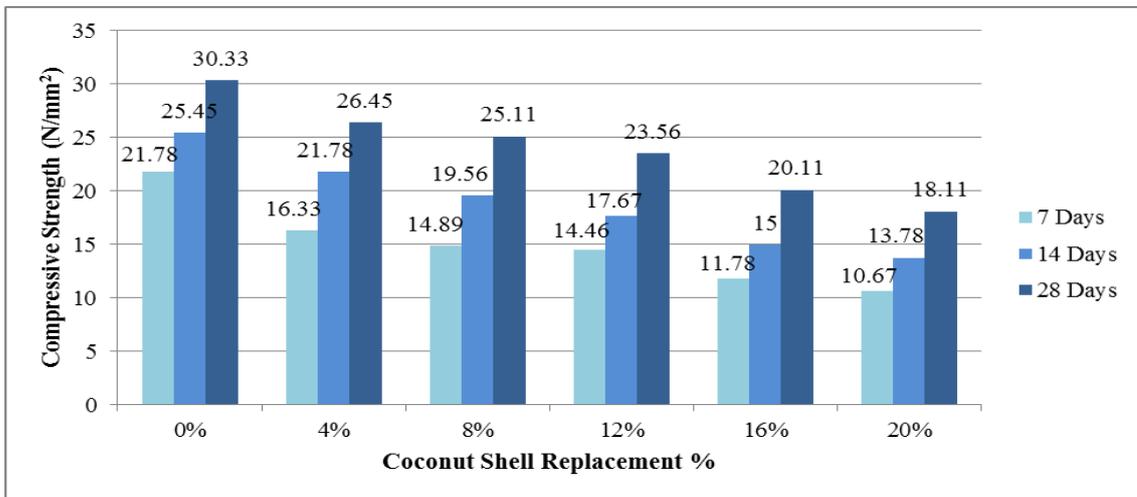


Figure 2: The relationship between Concrete Compressive Strength and Curing Days.

It can be seen from Figure 02 that compressive strengths decrease with the increase of the replacement of coconut shells. The compressive strengths achieved for 4% and 8% of coconut shell replacement satisfy the target strength of 25 N/mm² of the concrete mix design.

Splitting Tensile Strength

Figure 3 shows the variation of splitting tensile strength with the replacement of coconut shells.

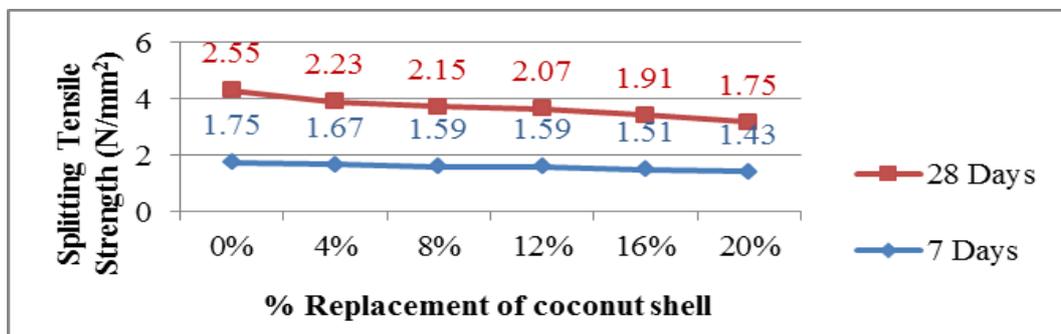


Figure 3: The relationship between Spitting Tensile Strength and a % Replacement of Coconut Shells

Water Absorption

Figure 04 shows the variation of water absorption of the concrete with the replacement of coconut shells

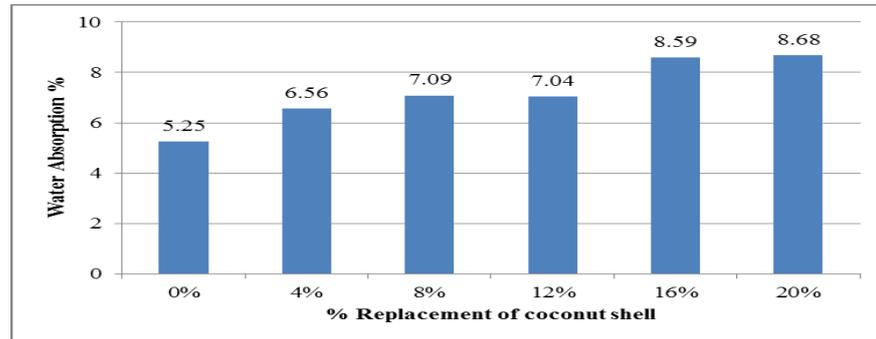


Figure 4: The variation of water absorption of concrete with a % replacement of coconut shells

It is observable that the water absorption of the concrete increases with coconut shell replacement.

CONCLUSIONS/ RECOMMENDATIONS

The properties of coconut shells are compared with those of conventional coarse aggregates to find the suitability of coconut shells as a replacement of coarse aggregates of concrete. Several conclusions can be drawn from the present work. Coconut shells have high toughness and abrasion resistant properties. The compressive strength decreases with increases of coconut shell content in the concrete, but gave satisfactory strength values after 28 days. It is observed that a proportion in the range of 4% - 8% satisfied the target strength 25 N/mm² (grade 25). However, grade 20 (20 N/mm²) concrete is attainable by using replacement proportions of above 12%, but less than 20%. The water absorption of the concrete gradually increases with an increasing percentage replacement of coconut shell. Marginal tensile strength improvements were noticed when the coconut shell percentage was 4 % to 8 %.

It is worth comparing the value of 1 ton of waste coconut shells, which are available for Rs. 3000, with the same mass of a crushed rock aggregate (20 mm) at Rs. 5000.

The results from this research suggest that coconut shells can be applied as a partial substitute for a coarse aggregate in concrete in percentages subject to the characteristic qualities required in the structural member of normal concrete applications.

This study will help in reducing the usage of depleting resources by reducing the use of natural rock aggregate and in minimizing environmental hazards through waste disposal by making use of coconut shell as a construction material.

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ANALYSIS OF BLAST LOADING EFFECTS ON ELEMENTS OF REINFORCED CONCRETE BUILDINGS

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INTRODUCTION

A bomb explosion within or immediately nearby a building can cause catastrophic damage on the building's external and internal structural frames, collapsing of walls, blowing out of large expanses of windows, and the shutting down of critical life safety systems. Loss of life and injuries to occupants can result from many causes, including direct blast effects, structural collapse, debris impact, fire and smoke. The indirect effects can combine to inhibit or prevent timely evacuation, and thereby contribute to additional casualties. Hence, buildings used by the general public daily must also have satisfactory blast protection. Integrating blast design in-to existing norms for structural design is a challenge, but it is achievable. The consideration of damage of structural components is limited and this is important for assessing the vulnerability of buildings against blast loadings (Draganić 2009).

The analysis and design of structures subjected to blast loads require a detailed understanding of complex blast phenomena and the dynamic response of various structural elements. This study is aimed at modeling and assessing an existing building using a numerical approach. Such a modeling is essential to visualize the structural response of a structure against blast effects and to propose remedial measures to strength the structure.

METHODOLOGY

The main objective of this study is to evaluate blast effects on elements of reinforced concrete (RC) buildings, considering experimentally determined dynamic characteristics. The study consists of three phases; (1) A literature survey on blast loading, (2) The theoretical calculation of the characteristics of blasting effects according to the Unified Facilities Criteria (UFC 2008), and (3) The numerical modal analysis involving non-linear time history analysis carried out on a three-story reinforced concrete building using the SAP2000 v15 general purpose software package.

Figure 1(a) shows a view of the building used in this study, which is the Open University of Sri Lanka (OUSL) CRC building, that was constructed in 2013. It consists of lecture rooms and some offices of the OUSL and lies beside the Nawala-Nugegoda road.

Columns and beams were modeled as frame elements while the slabs were modeled as shell elements. Dimensions of the building are shown in Figure 2. A charging explosive material was assumed to be placed R (m) away from the building in the Nawala-Nugegoda road side. The stand-off distance (R) was considered to be 13.7m (45°) and 27.4m (90°). The charging material was TNT and weight (W) varied from 50kg, 100kg and 200kg (Figure 2). Therefore, six blasting scenarios were created. The nature of loading was dynamic and the theoretical calculation was performed using the Unified Facilities Criteria of the United States Army (UFC 2008), and the pressure loading on the four sides of the building that was obtained are shown in Figure 3. Table 1 shows the specimen calculation for charging a weight of 50-kg TNT and a stand-off distance of 13.7m (45°).

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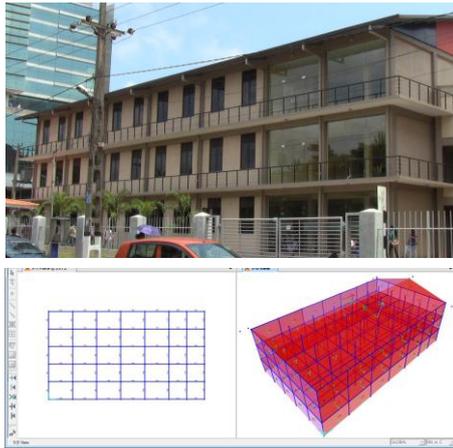


Figure 1(a): A view of the CRC building;
(b) SAP 2000 model of the building.

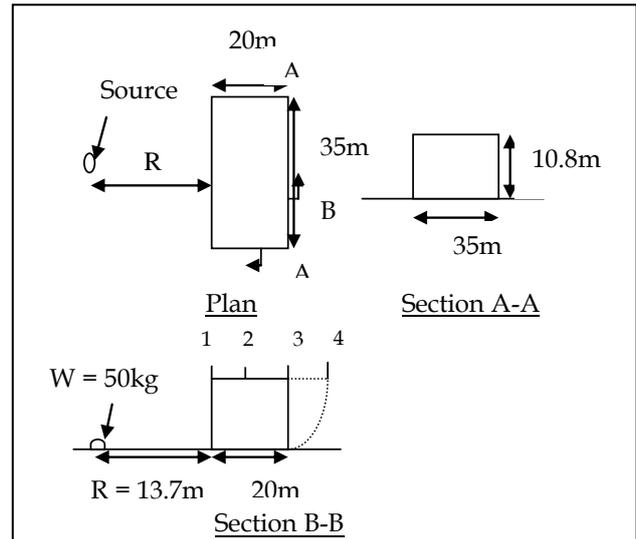


Figure 2: Sectional dimensions of the CRC building

Table 1: Specimen results for W = 50kg, R= 13.7m (45ft)

Loading face	Pressure (kNm ⁻²)	Time (ms)	Loading face	Pressure (kNm ⁻²)	Time (ms)
Front wall loading (1)	211.326	0	Roof loading (3)	0	0
	0	5.313		16.155	6.191
	0	11.719		0	11.719
	-20.690	23.642		0	39.141
	0	55.877		-10.086	29.603
				0	77.957
Side wall loading (2)	0	0	Rear wall loading (4)	0	0
	6.717	12.025		3.848	16.916
	0	43.819		0	51.818
	0	15.846		0	17.833
	-4.303	33.455		-2.538	35.030
	0	81.065		0	81.523

Figure 3 shows the pressure distribution over four sides of the building. This loading was applied to the finite element model (FEM) model of the building. The nature of loading was dynamic, and therefore a dynamic time history analysis was performed. Table 2 shows the peak reflected over pressures for different W-R combinations.

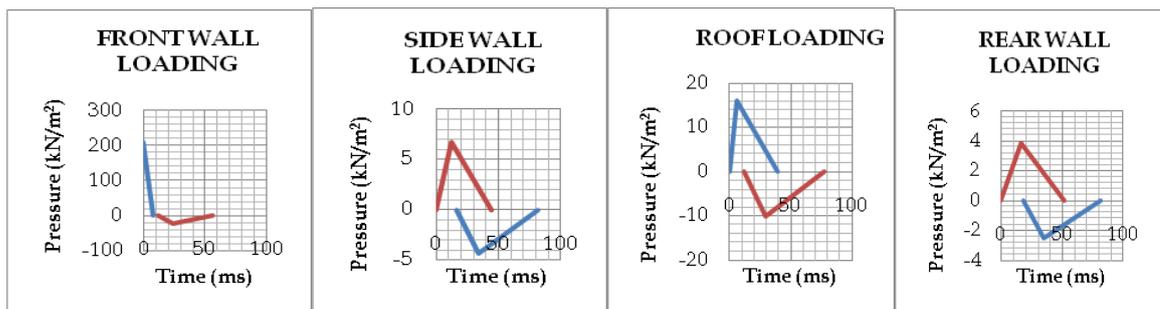


Figure 3: Pressure distribution over four walls of the building

Table 2: Peak reflected overpressures P_r (in kNm^{-2}) with different W-R combinations

W \ R (m)	50kg TNT	100kg TNT	200 kg TNT
13.7	211.326	421.931	705.931
27.4	52.524	63.840	95.421

Figure 4 shows a frame labeling node diagram of the front frame of the building according to the SAP2000 model.

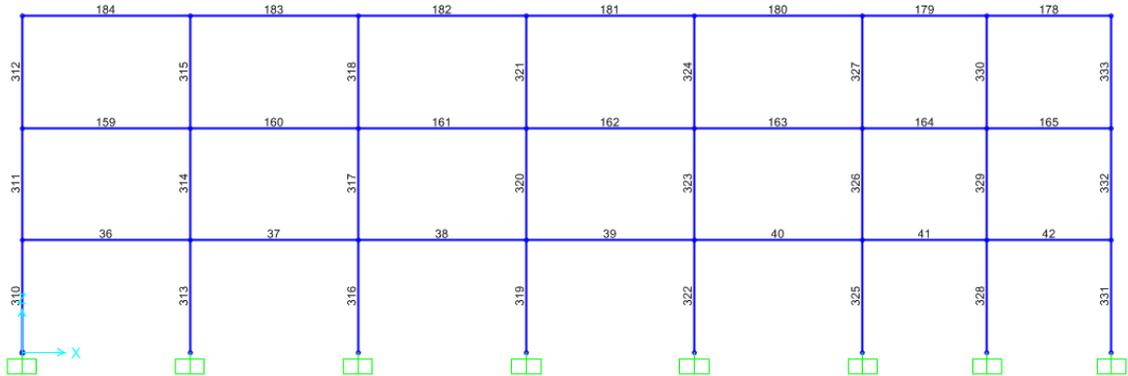


Figure 4: Node diagram for front structural frame

Calculated pressures-time history was applied to the SAP2000 FEM. A design check was performed using the ACI 318-05 code, which considers the plastic hinge formation in the failure. The deformed shape of the building due to $W=50\text{kg}$ and $R=13.7\text{m}$ is shown in Figure 5. According to the analysis results, six of the beams (Section Nos: 178,179,180,182, 183 and 184) failed due to the combined dead loads, live loads and blast loads, and no further critical columns were identified.

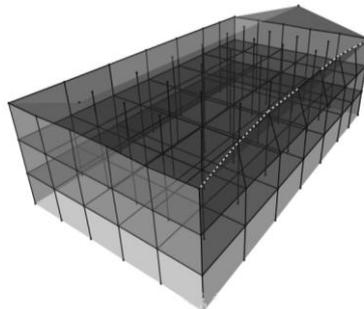


Figure 5: Deformed shape of building due to $W=50\text{kg}$, $R=13.7\text{m}$

The section No. 178 beam was a very critical element. The resultant beam design data of beam 178 with length is tabulated below;

Table 3: Resultant element forces on beam 178

Beam	Length	Step	P	V ₂	V ₃	T	M ₂
	m	Type	kN	kN	kN	kN-m	kN-m
178	0	Max	4.69	0.22	1.48	42.39	18.09
178	0.5	Max	4.69	0.22	1.48	42.39	18.98
178	1	Max	4.69	0.22	1.48	42.39	19.87
178	1.5	Max	4.69	0.22	1.48	42.39	20.76
178	2	Max	4.69	0.22	1.48	42.39	21.65
178	2.5	Max	4.69	1.39	1.48	42.39	22.54
178	3	Max	4.69	2.72	1.48	42.39	23.44
178	3.5	Max	4.69	4.04	1.48	42.39	24.33
178	4	Max	4.69	5.37	1.48	42.39	25.22
178	0	Min	-9.51	-5.23	-1.82	-26.05	-8.13
178	0.5	Min	-9.51	-3.91	-1.82	-26.05	-8.82
178	1	Min	-9.51	-2.58	-1.82	-26.05	-9.51
178	1.5	Min	-9.51	-1.26	-1.82	-26.05	-10.20
178	2	Min	-9.51	-0.17	-1.82	-26.05	-10.89
178	2.5	Min	-9.51	-0.17	-1.82	-26.05	-11.58
178	3	Min	-9.51	-0.17	-1.82	-26.05	-12.27
178	3.5	Min	-9.51	-0.17	-1.82	-26.05	-12.96
178	4	Min	-9.51	-0.17	-1.82	-26.05	-13.65

Notation: P = Axial force T = Torsion V_2 = Shear force in 1-2 plane

M_2 = Bending moment in the 1-3 plane (about the 2-axis) V_3 = Shear force in 1-3 plane

RESULTS AND DISCUSSIONS

There is a significant lateral deformation of front columns at the 2nd floor level. Further, the beam tie beam arrangement at roof level is beyond the capacity, and resulted in a structural failure through the plastic hinge formation that would be imminent under such a blast loading. The Finite element analysis results for the CRC building's stage II building, due to a blast explosion, with different charge weights (W) with various stand-off distances (R) can be summarized as below:

Table 4: Summary of analysis results

Charge Weight (kg)	Stand Off Distance (m)	Number of Failure Object		
50	13.7 (45°)	0	Column	all members pass
		6	Beam	178/179/180/182/183/184
	27.4 (90°)	0	Column	all members pass
		0	Beam	all members pass
100	13.7 (45°)	3	Column	318/321/324
		6	Beam	178/179/180/182/183/184
	27.4 (90°)	0	Column	all members pass
		5	Beam	178/179/180/182/184
200	13.7 (45°)	5	Column	315/318/321/324/327
		1	Beam	176/177/178/179/180/181/182/183/184/185/186
	27.4 (90°)	0	Column	all members pass
		6	Beam	178/179/180/182/183/184

CONCLUSIONS AND RECOMMENDATIONS

A blast load for a near-by explosion was determined and simulated on an FEM building model using SAP2000, a general purpose software package. Loading was defined as a non-linear pressure-time history. It revealed that the model building was not capable of withstanding the given blast loading, and hence a partial collapse of the building occurs. Based on these findings,

it is recommended that the guidelines on abnormal load cases, such as blast loadings and provisions on progressive collapse prevention, should be included in the current Building Regulations and Design Standards.

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EFFECTS OF CONTAMINATED SOILS ON SURVIVAL, GROWTH AND REPRODUCTION OF *EISENIA ANDREI*

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INTRODUCTION

Global agriculture has largely succeeded in satisfying world demand for food over the last several decades with intensive agricultural production, and it contributes to covering a large portion of the global food demand (Giller et al. 1997) and is *directly* linked with the heavy use of pesticides. It was estimated that 2.5 million tonnes of pesticides are applied to agricultural crops worldwide each year (Van der Werf 1996). As a consequence of the green revolution, agriculture in Sri Lanka has undergone significant intensification in the last decades. Pesticide management is a serious problem in the local context. Farmers neglect technical recommendations and apply according to their own experiences due a to lack of knowledge and guidance. (Thiruchelvam and Bandara 2008). Agricultural soil has been considered to be a primary recipient for agrochemicals and synthetic inorganic fertilizers (Pereira et al. 2009). It has been estimated that approximately 1% of pesticides applied to the agriculture reach their target pest and more than 99% of it adversely affects non-target and beneficial organisms (Atreya et al 2012) such as soil invertebrates. Earthworms are an important group that has been considered as a bio-indicator species in the terrestrial ecosystem and a good model organism to determine the effects of agrochemicals. *Eisenia andrei* (*Oligochaeta*; *Lumbricidae*) is a standard earthworm species used in ecotoxicology (ISO, 1998b; OECD, 2010). *Eisenia andrei* is an epigeic earthworm that inhabit in surface litter in soil. Their relatively short generation time, high cocoon production, continuous breeding, wide temperature and moisture tolerance, cosmopolitan distribution and easy culturing under laboratory condition have led *E.andrei* to be selected as a standard species for soil ecotoxicology (De Silva et al. 2009). It is hypothesized that the heavy loading of agrochemicals persists in the soil ecosystem, which result in short- and long-term effects on soil fauna. Hence, in the present study, we study the effects of contaminated soils on survival, growth and reproduction of the tropical variant of earthworm *Eisenia andrei* to develop it as a potential bio-indicator in agro ecosystems.

METHODOLOGY

Six sites were selected randomly in the hill country, from Nuwaraeliya to Bandarawela, as possible contaminated sites based on information from farmers. Two uncontaminated sites were selected in Diganatenna area representing the same study area and another site near the Ruhuna University, Matara. Both control sites had no record of previous contamination due to agrochemicals. A random sampling design was used to obtain a composite soil sample per site in the 0-5cm soil surface layer. The organic matter content, maximum water-holding capacity and the pH were tested for each soil sample. Soil samples from the selected sites (n=5) were collected and sieved to get a homogeneous structure. A standard artificial was used as a reference soil that was developed according to OECD guidelines by mixing 70% quartz sand, 20% kaoline clay and 10% sphagnum peat with a small amount of CaCO₃. The epigeic earthworm *Eisenia Andrei*, cultured under laboratory conditions, was selected as the test species. Glass bottles (750ml) were filled with 500g (dry weight) of each test soil samples. It was moistened to 50% of their respective maximum water-holding capacities. Age synchronized adult earthworms (300mg-600mg) with well-developed clitellum were obtained

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from cultures at the Department of Zoology, University of Ruhuna, Matara and introduced into the containers with moistened soil. The initial mass of earthworms was determined before exposure to soil samples and the bottles were incubated at 26 ± 2 °C and 12:12 hour's photoperiod for 28 days. Five grams of moistened, finely-ground cow manure was added as the food. After 28 days, adults were removed by hand sorting, and the surviving earthworms were counted. The final biomass of the remaining adults of each container was also recorded. After this, the soil was returned to the test containers and incubated for another 28 days for cocoon development. After 56 days, juveniles were extracted from the test soil using a water bath kept at 60 °C and the numbers of juveniles were counted. The final endpoints were adult survival, change of biomass after 28 days, and the number of juveniles produced after 56 days. The results were tested for their normal distribution with the Komogorov-Smirnov test and homogeneity of variance with the Levene's test. Results were analyzed by one way ANOVA using SPSS software version 16.0.

RESULTS AND DISCUSSION

The tested soil parameters were in optimal range for earthworms. Therefore, the soil parameters of each site did not contribute to the changes of the end points from site to site. There were no effects on the survival of adult earthworms in all control soils because they were free from agrochemical contamination. The performance of *Eisenia andrei* in OECD artificial soil (AS) and the Matara control soil (MCS) were the same. In the Diganatenna control soil (DCS), the performance of *Eisenia andrei* varied from the other two types of control soils. This may be due to the physical and chemical properties of soil. Significant biomass loss was recorded from AS and MCS, but a higher biomass gain was recorded in DCS. In earthworm growth test, effects of control soil on biomass loss were highly significant ($F= 100.354$, $p < 0.001$) and the mean percentage weight of adults in DCS was significantly different from the AS ($p < 0.001$) and MCS ($p < 0.001$).

In contaminated soil samples, no effects on survival were also recorded during the 28-day exposure period. Homogeneous distribution of earthworms in the experimental bottles was observed in each of the replicates and it may be due to the level of soil contamination and rather low or not lethal to *Eisenia andrei*. This may have resulted due to an agrochemical degradation paradigm in the natural environment and multiple degradation pathways that occurred at field conditions. It results rapid degradation, volatilization and photo decomposition (Van der Werf 1996). After 28 days of exposure, the mean weight was reduced in all tested contaminated soil samples. The highest mean biomass loss was recorded at the Diganatenna contaminated soil (CSD) and the lowest value was in the Pattipola contaminated soil (CSP). It was reported that the mean weight change of the earthworms was significantly different ($p < 0.05$, Figure 1 and Figure 2) from the control soils, AS and MCS. The mean weight loss of adults in CSP was significantly lower from the OECD artificial soil (AS) and MCS ($p < 0.05$). Compared to DCS, the overall effects of the different contaminated soil types on the mean weight change of the earthworms was significant ($F= 22.756$, $p < 0.05$, Figure 3). According to the Dunnetts test, the growth of adults in all contaminated sites has had a significantly higher mean weight loss when compared to CSD ($p < 0.05$) except CSP.

The highest mean number of juveniles was recorded at the Ambewela contaminated soil (CSA) (175.6 ± 40.8) and CSP (163.8 ± 24.5) and the lowest in CSD (16.6 ± 7.0). The soil samples taken from CSP and ASP recorded the highest significant mean numbers of juveniles when compared to AS and MCS ($p < 0.05$, Figure 4 and Figure 5). A high number of juveniles in CSA and CSP could be linked to higher organic matter in the content. It was recorded that the use of cow dung as manure in the Pattipola and Ambewela farms, and it may positively affect the performance of earthworms. On the other hand, organic matter in the soil may reduce bioavailability of the agrochemicals resulting in a higher reproduction potential in the tested soils. However, the number of juveniles in the Nuwara Eliya (CSN), Boragas (CSB)

and Keppetipola (CSK) contaminated soils were not significantly different from the mean number of juveniles in AS and MCS ($p > 0.05$). The mean number of juveniles produced after 56 days also varied in different test soils ($p < 0.05$, Figure 6) from DCS. A significant lower number of juveniles were recorded from CSA, CSN, CSK and CSD contaminated soils ($p < 0.05$) from DCS. It can be predicted that sub lethal endpoints, such as growth and reproduction, are more sensitive than survival, although the level of contamination was not lethal to the tested earthworms. However, in the long term, persisting soil contamination can still cause serious effects on growth and the reproduction of earthworms.

CONCLUSIONS/RECOMMENDATIONS

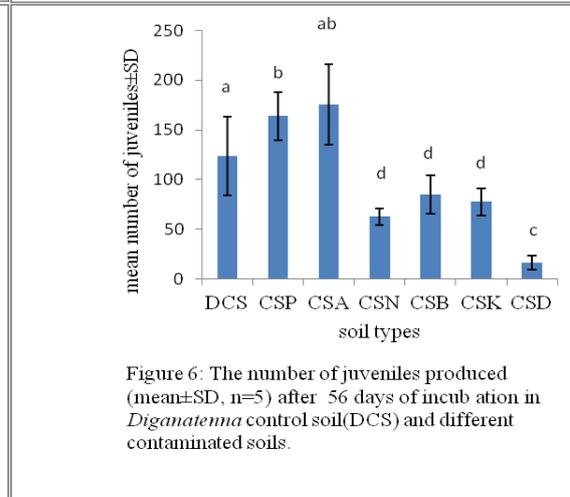
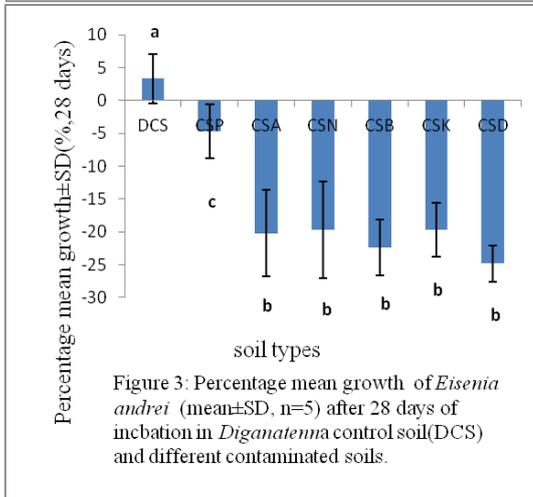
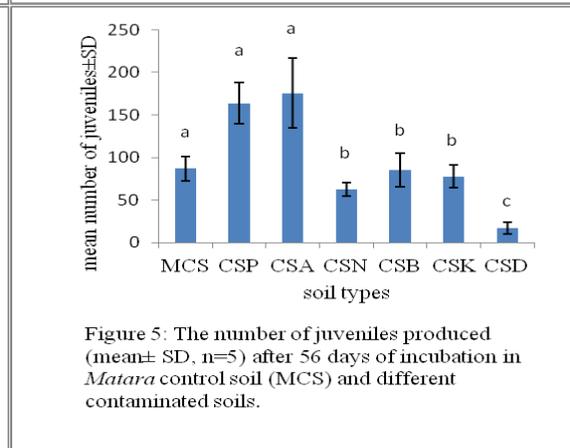
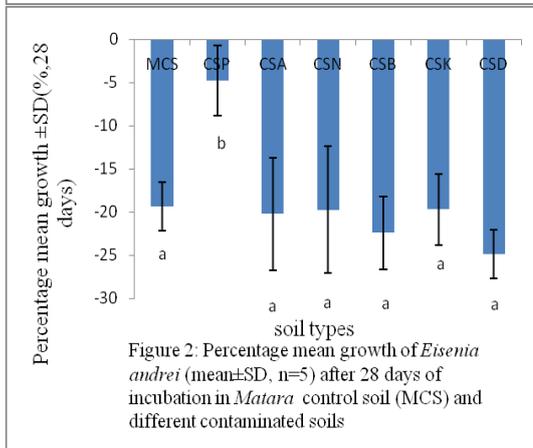
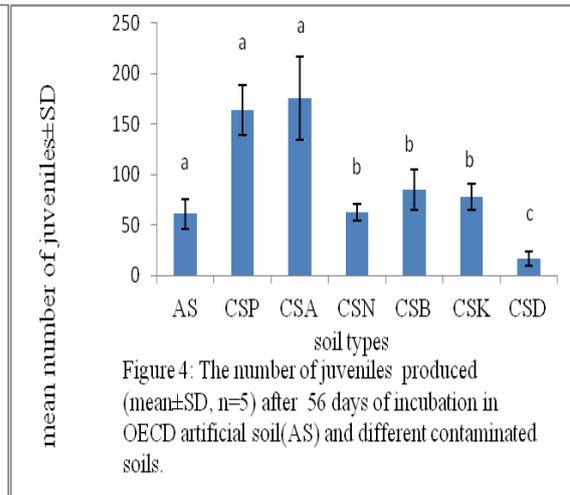
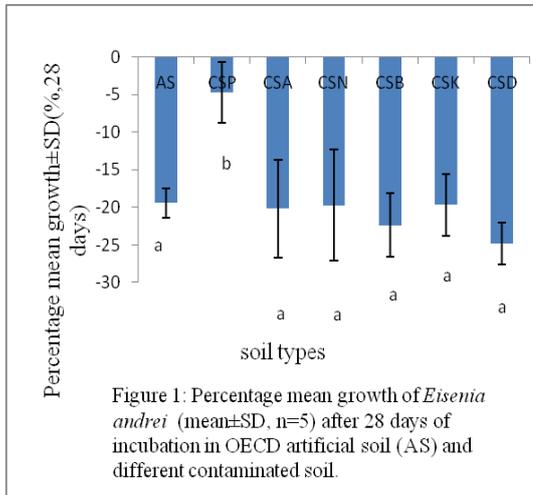
The degree of soil contamination was not lethal to *Eisenia andrei* for the tested six contaminated soils. In addition, long term endpoints, such as growth and reproduction, have also confirmed that the level of contamination in the studied contaminated soils (Pattipola, Ambewela, Nuwara Eliya, Boragas and Keppetipola) have no serious effects on growth and reproduction of *Eisenia andrei* except in the Diganatenna contaminated soil. This study is the first to establish survival, growth and reproduction data for six soil types in arable lands from Nuwara Eliya to Bandarawela. These generated values can be used as standard initial values for the development of a bio-indicator index. Further, the development of such indices can be accomplished with more sampling sites in the area. In addition, soil sampling should also be done in different periods of the crop cycles, such as just after spraying, a day before spraying and a day after spraying of agrochemicals and application of synthetic fertilizers.

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THE EFFECTIVENESS OF LOCAL PLANTS AS NATURAL COAGULANTS IN TREATING TURBID WATER IN SRI LANKA

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INTRODUCTION

The removal of turbidity is essential in producing potable drinking water. In a conventional water treatment process, the coagulation/flocculation stage removes or reduces turbidity in the form of suspended and colloidal material. As many of our water supply sources depend on rivers, streams and lakes, this is an important process to remove turbidity, bacteria, algae, color, organic compounds and clay particles (Babu and Chaudhuri, 2005).

The coagulants can be categorized broadly into three classes as inorganic (eg.. aluminum sulfate, polyaluminium chloride and ferric chloride), synthetic organic polymers (eg., polyacrylamide derivatives and polyethylene imine) or natural coagulants (eg., chitosan and plant extracts) (Sutherland et al, 1999). It has been stated by many researchers in the past that the residuals of some synthetic organic polymers, such as acrylamide, have neurotoxicity and strong carcinogenic properties (Folkard et al, 1999). Besides, many developing countries can hardly afford the costs of imported chemicals for water and wastewater treatment. On the other hand, natural coagulants are biodegradable and are presumed to be safe for human health (Fugate et al, 2008). Many studies on natural coagulants have already been carried out and various natural coagulants have been produced or extracted from microorganisms, animals or plants (Marobhe, 2008).

The use of natural materials of plant origin to clarify turbid raw waters is not a new idea (Šćiban, *et al*, 2005). Natural coagulants have been used in domestic households for centuries in traditional water treatment in rural areas in many different countries. In the recent past, more interesting studies have been carried out on the subject of natural coagulants, especially to reduce problems of water and wastewater treatment in developing countries and to avoid health risks. Studies have been conducted to evaluate the coagulation efficiency of many plant materials, including the extract of Moringa seeds (*Moringa oleifera*) (Ndabigengesere *et al.*, 1995), tamarind seeds (*Tamarindus indica*) (Bhole, 1995) and vegetable tannins (Özacar & Şengil, 2003). Huang and Chen (1996) studied the coagulation potential of chitosan, one of the most effective natural coagulants extracted from the organic skeletal substance in the shells of crustaceans. The preliminary study of the coagulation efficiency of the Moringa seed was carried out by Jahn (1984) in Sudan.

Sri Lanka is a country that is blessed with weather that supports the growth of various types of trees. From traditional knowledge, it has been identified that Kumburu (*Caesalpinia*) and Igini (*Strychnos potatorum*) seeds and the Kumbuk root (*Terminalia arjuna*) have abilities to purify water. The Water Board of Sri Lanka spends about Rs. 0.28, for the cost of alum only, to remove turbidity per 1m³ of water. However, it was discovered that although such plant seeds seem to be effective water clarifiers, good coagulation results were not always obtained due to a lack of understanding on how the seed powder coagulates turbid waters. The aim of our study is to investigate the suitability of locally available plants as natural coagulants.

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METHODOLOGY

Preparation of seed extracts

As stated above, seeds of three locally grown plants were identified to be used as natural coagulants. Moringa (*Moringa oleifera*) is a highly valued plant, distributed in many countries of the tropics and subtropics. It has an impressive range of medicinal uses with a high nutritional value (Jahn *et al*, 2006). People in Sri Lanka have been using it as an item of their daily diet. In addition to that, it has compelling water purifying properties.

Moringa pods were collected from surrounding areas and dried for several days. Then the pods were chopped and their seed kernels were separated. Thereafter, the separated seeds were dried for several days. Approximately 10kg of moringa pods were needed to make 100g of seed powder. Kumburu and igini seed powders were also prepared in the same manner. Kumbuk roots were collected and washed, and the roots were dried for several days. The above seed kernels were ground into fine powder using a blender. Seed powder with different grain sizes were obtained by sieving through mesh sizes of 0.3, 0.6 and 1.18 mm.

Preparation of synthetic turbid water

Turbid raw water samples were collected from the intake chamber of the treatment plant at Malimbada, Matara. As soon as the samples were collected, they were brought to the laboratory of the treatment plant. Immediately before coagulation experiments were conducted, suspensions were prepared with initial turbidity which was High, Medium and Low. These samples were made by adding clay particles into the above raw water samples and stirring well. Then the resultant mixture was filtered through No. 1 Whatman filter paper.

Coagulation test

Preparation of alum solution

An Alum solution was prepared by dissolving 1g alum, $\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$ in 100ml of distilled water. A Jar test was used for the evaluation of the coagulation processes. Coagulation activity of each seed extract was verified by the jar test. The synthetic turbid water of High initial turbidity was added into six 1000ml beakers into which individually and separately 1, 1.5, 2, 2.5, 3 and 3.5ml of the alum solution were added (Water Board Report, 1989). 1ml of lime water ($\text{Ca}(\text{OH})_2$) was also added to each beaker at the same time for pH adjustment. The mixtures were mixed thoroughly at 180rpm for 3 min and continued at 30rpm for 30 min. Finally, the samples were allowed to settle 30 minutes. After sedimentation of 30 minutes, residual turbidity (RTS) was measured, and the pH was measured at six beakers. The same coagulation test was conducted with natural coagulants using the same procedure with 2% alum solution. The residual turbidity (RTB) and pH were measured.

RESULTS AND DISCUSSION

Jar tests were conducted to determine optimum pH values and the dosage of alum. In the Jar test, the pH level should be controlled in order get the optimum result. The traditional way of controlling the pH is adding lime ($\text{Ca}(\text{OH})_2$) as the final solution tends to have lower pH value due to the alum.

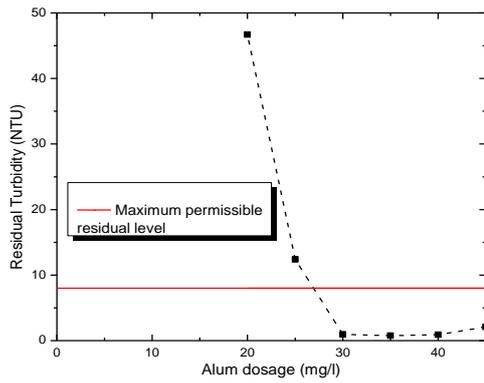


Figure 1a: Turbidity removal using alum

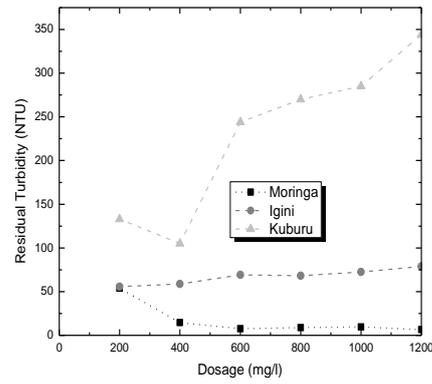


Figure 1b: Turbidity removal using natural coagulants for initial high turbidity

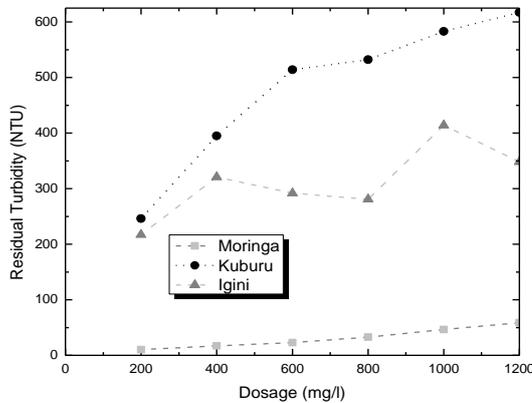


Figure 1c: Turbidity removal using natural coagulants for initial low turbidity

Figure 1a shows the test results of the variation of residual turbidity against the alum dosage. A minimum turbidity of 0.77 NTU was obtained when the alum dosage was 35 mg/l and the pH value was 6.9. In the same manner, tests were conducted for the natural coagulants, but with high and low initial turbidity levels. The variation of turbidity against the different natural coagulants dosages is illustrated for low turbidity samples in Figure 1b, and for high turbidity samples in Figure 1c.

According to the above figures, Kuburu, Igini and Kumbuk show low performances in removing turbidity, while Moringa is the only one coagulant that has a higher ability to remove turbidity. Therefore, a further study was carried out to investigate into the ability of Moringa to remove turbidity. A number of tests were performed for High turbidity and Low turbidity water for different particle sizes. Figures 2a and 2b show tests results with Moringa.

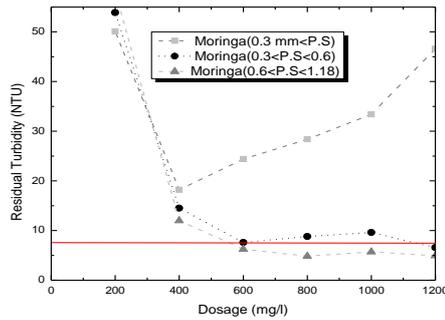


Figure 2a: Effects of particle size for high initial turbidity

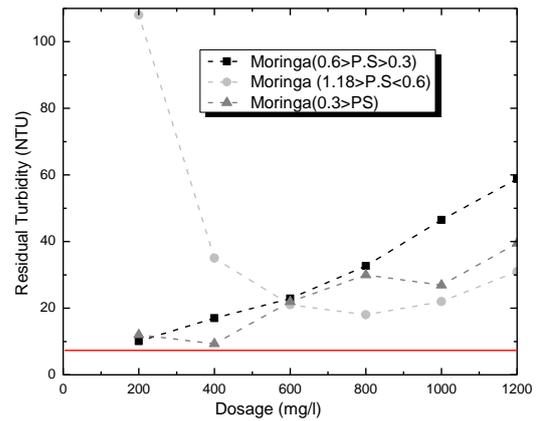


Figure 2b: Effects of particle size for low initial turbidity

The line going through 8 NTU represents the maximum permissible turbidity level (8 NTU, Design Manual D3 1989 there was a Water Board report in page 2; is it the same? If so stick to that, be consistent). The residual turbidity value below the above line satisfies the standard for drinking water in relation to turbidity. Figure 2a shows that the use of coagulants with particle sizes in the range 0.6 - 1.18 mm OR μm ? and dosages between 550 mg/L and 1200 mg/L achieves the required level of turbidity removal. The required dosage for the particle size ($0.3 < \text{PS} < 0.6$) is 600 mg/l. Figure 2b shows the variation of residual turbidity for high turbidity water. A particle size that is less than 0.3 mm gives results close to the drinking water standard.

CONCLUSIONS

In this study, we have investigated the effectiveness of locally available plant parts to reduce turbidity of surface water. The three plants that were identified for the study are Moringa, Kumbuk and Kuburu. In the conventional treatment process, 35 mg/L of alum is necessary to bring down turbidity to an acceptable level. The turbidity removal capacity of Kumbuk and Kuburu were not as effective as Moringa, which grows well in the dry zone of Sri Lanka. Therefore, powder prepared from these seeds can be used domestically to clarify water free of charge.

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IMPACT OF CLIMATE CHANGE ON WATER RESOURCES IN CENTRAL HILLS OF SRI LANKA AND POSSIBLE ADAPTATION MEASURES

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INTRODUCTION

Lack of water and occurrence of drought are causing lower yield and less work for the community in the tea lands of the central hill country. The Estate Sector is still confronted with an inadequate supply of safe drinking water, proper housing and toilet facilities, and a lack of resources for education (Ariyabandu, 1999). Therefore they are less aware of the minimum requirement for good health. A safe water supply has not only been recognized as a basic need of people, but is also essential for healthy life. Unsafe water has become a significant vehicle for water borne diseases, and is the major cause of illness among the communities in the central hills. Although about 65 percent of estate communities fulfill their water requirement from pipe borne water supply, a scarcity of water resources requires them to travel long distances to fetch water. In many instances such water sources are polluted and are a cause for major water related problems.

A further water related problem is the damage caused as a result of floods. This is almost an annual feature during the major rainy seasons. For instance, the city of Ratnapura, situated in the wet lowlands of Sri Lanka and located beside the Kalu Ganga is famous for its annual inundation. The rise in the water level of the Kalu Ganga River contributes to much damage to the city dwellers. Additionally, during high rainfall periods, more than 20% of the urban area is inundated by flood water around the city caused by the accumulation of rainfall within 270 square kilometers covering the upper part of the drainage basin. The city's urban area spreads over 20 square kilometers with a population of 46,300. These inhabitants not only face the natural hazards associated with periodic flooding, but also slope instability associated with mass movement and a number of other environmental problems created by their own activities (Pallawala, 2004). The damage incurred due to the floods which occurred in 2003, is estimated as being around 1.140 million rupees, with a death toll of around 122. Furthermore, the lowlands of Nuwara Eliya and Kandy also experience heavy floods and landslides during the southwest monsoon resulting in much damage to life and property. It is expected that with climate change impacts the situation will be further intensified in the future. Therefore to this issue appropriate development planning is an urgent need.

RATIONALE AND OBJECTIVE

Climatic changes have severely affected the Sri Lankan economic, social, and agricultural sectors due to the high dependency on rainfall for power generation, irrigation, agriculture, domestic and industrial usage and human consumption. The frequency of floods, landslides and droughts have increased drastically in the Central Hills of the country (Ariyabandu, 1999 and Rajapaksha, 2003), and there is an urgent need to study the impacts of climate change on future water resources in the Central Hills of the country. Therefore this paper intends to analyse the climate change impacts on water resources based on HadCM3 model prediction for 2050 in Central Hills of Sri Lanka and possible adaptation measures.

METHODOLOGY

There are few Global Circulation Models (GCMs) developed by various countries (Gordon *et al*, 2000) and these models predict the future climate change in climatic variables such as

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rainfall, temperature, wind speed, relative humidity based on the greenhouse gases, sea level rise and other related parameters for the whole world except Antarctic regions for 2020s, 2050s and 2080s (Hulme *et al.*, 1998). Therefore the results are in larger pixel points such as 300km x 300km to cover the whole world. It creates problems for small countries such as Sri Lanka which can only use two or three pixels points to extract the results of the global circulation models. It does not mean that the GCM results cannot be used for Sri Lanka or not reliable for Sri Lanka. There are scientifically and internationally accepted downscaling procedures available to downscale original 300km x 300km pixel results as predicted by GCM to the 10km x 10km pixel as used by Sri Lanka (New *et al.*, 2002). Therefore, downscale of GCM results on climate change predicted for in 2020's, 2050's and 2080s could be scientifically used to predict the rainfall and temperature changes in the study areas using baseline data from 1961-1990.

The climate change predictions for 2050s have been studied for Sri Lanka using climate change projections of HadCM3- a GCM of Hadley Centre for Climate Prediction and Research, UK. These numerical models representing physical processes in the atmosphere, ocean, cryosphere and land surface are the most advanced tools currently available for simulating the response of the global climate system to increasing greenhouse gas concentrations. HadCM3 is a coupled atmosphere- ocean general circulation model (AOGCM) which has previously been used (Gordon *et al.*, 2000). These predictions were then applied to the Inter-governmental panel of climate change (IPCC) Emission Scenario A2 which is the scenario for highest sea level rise, carbon dioxide concentration, temperature rise and population rise and therefore demarcated as worst impact case (IPCC, 2007). Simple water balance methods and runoff coefficient were used to estimate the potential soil moisture deficit, runoff and potential groundwater recharge. For this study three locations in Central Hills were used namely NuwaraEliya, Ratnapura and Kandy. Results of HadCM3 for 2050s - A2 scenario were compared with 1961-1990 data as baseline and past decade data (1999-2008) of the Meteorology Department.

RESULTS AND DISCUSSION

The annual average rainfall is predicted to increase in Ratnapura, NuwaraEliya and Kandy by 12% in 2050 (A2) scenario compared to the baseline (1961-1990). This is mainly due to the increase predicted during the southwest monsoon rainfall across the country by 38% (A2) and 16% (B2) in 2050s. The predicted increase in rainfall during the southwest monsoon period (May to September) in Ratnapura, NuwaraEliya and Kandy are 43%, 57% and 20% respectively in 2050 (A2) compared to the base line (1961-1990). The prediction results agree with the past decade (1999-2008) data collected by the Meteorological Department on the southwest monsoon rainfall which show an increase of 10% in NuwaraEliya (Figure 01). Further, among the wet zone areas the annual runoff in Ratnapura, NuwaraEliya and Kandy are predicted to increase and the predicted increase in Kandy is almost 100% compared to the baseline (1961-1990). Due to the increase in the surface runoff, floods also increase significantly in the Central Hills, resulting in increased landslides. Further, the Central Hills are predicted to receive an excessive amount of rainfall which causes excessive runoff floods and landslides in these areas during the 5 months of the southwest monsoon season (May to September) (De Silva *et al.*, 2007).

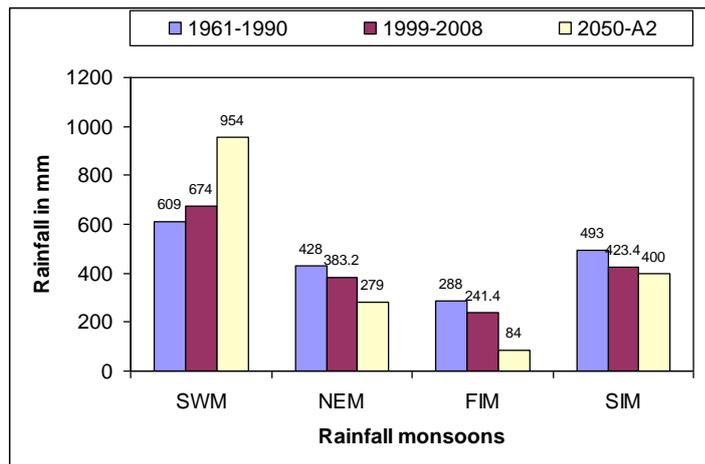


Figure 1: Rainfall in NuwaraEliya during Southwest- monsoon (SWM), Northeast- monsoon (NEM), first inter- monsoon (FIM) and second inter- monsoon (SIM) in mm for periods from 1961-1990, 1999-2008 and HadCM3 prediction for 2050.

Table 1: Predicted increase in runoff in percentage compared to the base line (1961-1990) in Kandy/Katugastota

Year	Kandy/Katugastota
2010	33.2
2020	49.8
2030	66.4
2040	83.0
2050	100

In contrast, during the northeast monsoon rains, in December to February, the annual average rainfall is predicted to decrease by 31%, 32% and 29% respectively in Ratnapura, NuwaraEliya and Kandy in 2050 compared to the base line (1961-1990). Further, during the second intermonsoon (October to November) too decrease in rainfall is predicted. Therefore the rainfall during October to February (northeast monsoon) is predicted to decrease in Ratnapura, NuwaraEliya and Kandy by 6%, 10% and 5% respectively in 2050(A2) scenario compared to the baseline (1961-1990). This agrees with the recent past decade (1999-2008). For example in NuwaraEliya the average annual rainfall has already decreased by 6%, 8% and 16% during the northeast monsoon, first and second intermonsoon respectively (Figure 01). It shows that the decreasing trend in northeast and first and second inter monsoon rainfall are proportionally high compared to the HadCM3 prediction in 2050s. Therefore for 7 months from October to May decrease in rainfall is predicted. Further the annual average temperature is predicted to increase in Ratnapura, NuwaraEliya and Kandy by 1.7°C, 1.1°C and 1.5 °C respectively in 2050 (A2) compared to the baseline. Because of this temperature increase, the maximum soil moisture deficit is predicted to increase by almost 100% in all these stations in the central hills. This will severe impact on the up-country vegetable cultivation which may need additional irrigation water for sustainability. On the other hand, the potential groundwater recharge is predicted to increase by 74%, 23% and 33% in Kandy, NuwaraEliya and Ratnapura respectively in 2050 (A2) scenario compared to the baseline.

CONCLUSIONS

According to the HadCM3 and the results obtained for 1999-2008, there is an increase in rainfall for 5 months during the southwest monsoon period. This will cause excessive runoff leading to floods and landslides. But for 7 months during the first, second inter monsoon and northeast monsoon the rainfall is predicted to decrease in the Central Hills which will severely impact up-country vegetable cultivation due to a shortage of water. Further it will affect the availability of water for drinking and domestic purposes.

Adaptation Measures

Adaptation measures should be designed to store the excess water when the demand for water is low in the Central Hills during the southwest monsoon for the months when there is no rainfall and the demand for water is high.

During the southwest monsoon period the excess water must be retained in surface ponds or small reservoirs or surface tanks wherever possible in the direction of water flow. Further, a series of water retention dams and structures could be erected in the downstream of each reservoir so that the spillway water could be retained rather than go waste. In the dry zone of Sri Lanka there is a cascade system where the excess water flows downstream and is collected in tanks placed one after another one after one thus ensuring minimum water loss. In the present system, there is no mechanism to store the spillway water in the downstream of the reservoirs, which have serious problems in water retention. Therefore; the system similar to the dry zone should be developed in the central hills wherever possible. When the slope is steep there should be mechanical structures constructed to reduce the velocity of the water and divert it to the surface ponds and surface tanks. By the careful planning of water retention and water management techniques the excess water during southwest monsoon period could be retained for future use.

In contrast, during the northeast monsoon, first and second inter monsoon period there will be decrease in rainfall as shown in the results. Therefore, the available rain water during the southwest monsoon must be used efficiently for sustainable agricultural activities. Drip and Sprinkler irrigation systems will increase the efficiency of the use of water. Further, cultivation in protected house/poly tunnels and green houses will reduce the impact of adverse climate. But the farmers involved in small scale farming can practice mulching and water retention methods such as ridge and furrows. Further, the farmers could consider crops which need less water. However, for drinking purposes the groundwater could be used as the potential groundwater recharge is predicted to increase based on HadCM3 data. But the use of groundwater should be done very carefully to make sure that there is no over exploitation of groundwater resources and sustainability should be ensured.

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INTER-DECADAL VARIABILITY OF SEASONAL RAINFALL IN SRI LANKA WITHIN THE PERIOD OF 1951-2010

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INTRODUCTION

Sri Lanka is a country with an agricultural economy; therefore the seasonality of rainfall is very important. The success or failure of the seasonal rainfall significantly effects agriculture and water availability on a regional basis, and therefore is of great concern. Nevertheless, a marked variability of seasonal rainfall always contributes to a negative impact on irrigation, hydro-power generation, drinking water, and especially on farm lands.

The distribution pattern of rainfall within an average year can be divided into four rainfall seasons: first inter monsoon season (FIMS), Southwest monsoon season (SWMS), Second inter monsoon season (SIMS) and northeast monsoon season (NEMS). During the FIMS (from March to April), there is a distinct spatial pattern of rainfall over the island with only the southwest slopes of the central highlands receiving more than 1000mm of rainfall, whereas it varies between 80mm and 400mm in the rest of the country. The SWMS (from May to September), is the longest and most spatially differentiated in respect of rainfall. The highest rainfall (more than 3000 mm) is concentrated on the medium heights of the western and southwestern slopes of the central highlands, increasing up to an altitude at about 1,000m. Rainfall totals decrease steadily towards the rest of the country. The SIMS (October and November) is the most evenly balanced rainfall season in the country. During this season, the southwestern slopes of the central highlands receive an average rainfall of 750-1,000mm. This is the wettest season in the country, as a whole. During the NEMS (from December to February), the amount of rainfall over much of Sri Lanka varies widely between 300-1,500mm. The highest values are observed over the east and northeastern sectors, and the lowest values in the western and southern coastal areas. During this season, there is no large-scale orographically-originated rainfall differentiation compared with the southwest monsoon season due to leeward or rain shadow slopes of the highlands, which can be discerned (Ranasinghe 2002).

Three major climatic zones have been identified in Sri Lanka based on rainfall, soils, land used patterns and the distribution of forest species of the country. The 'wet zone' covers the southwest region, including the central hill country. The 'dry zone' consists of predominantly northwestern, northern, eastern and southeastern parts of the country and is separated by an 'intermediate zone' from the wet zone.

OBJECTIVES OF THE STUDY

The present study aims to analyze the inter-decadal variability of seasonal rainfall in Sri Lanka within the period of 1951-2010 and to identify whether there is marked variability of rainfall between the three climatic zones of Sri Lanka.

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METHODOLOGY

Data Used

Seasonal rainfall data of 23 locations in Sri Lanka (representing one location for each district) for 60 consecutive years (1951-2010) are used for the study. It is needed to mention that only two districts (Kilinochchi and Mulathivu) have not been considered for the study due to several years lapsing with missing data. Monthly rainfall data were obtained from the Department of Meteorology, Sri Lanka. The obtained monthly data was segregated into the four rainfall seasons. Furthermore, the considered time period was divided into six decades: 1951-1960, 1961-1970, 1971-1980, 1981-1990, 1991-2000 and 2001-2010.

Statistical Methods Used for the Study

Among many statistical tests available to detect the variability of rainfall, the coefficient of variability (CV) is considered to be a more robust approach and is a commonly used statistical tool to measure rainfall variability. Hence, the present study used the CV approach for the identification of inter-decadal variability of rainfall. CV refers to a statistical measure of the distribution of data points in a data series around the mean. It represents the ratio of the standard deviation to the mean. Generally, low rainfall variability is associated with lower CV values and vice versa. Being calculated as the ratio of standard deviation to the mean, the coefficient of variation is computed using the following equation:

$$(CV = SD \div Mean * 100)$$

Where, CV= Coefficient of Variability

SD=Sample Standard Deviation

75% Probable Rainfall

Calculating the reliability of rainfall can be taken into account as a satisfactory statistical tool to measure the variability of rainfall. Generally, there is a positive correlation between mean seasonal rainfall and the reliability of rainfall (Sirinanda 1970). Therefore, the spatial distribution of the reliability of rainfall positively coincided with the spatial pattern of the mean seasonal rainfall in Sri Lanka (as explained at the introductory section). Reliability of rainfall can measure using different probability levels, for example, 70, 75, 80, 85 and 90%. In the present study, a special focus will be on rainfall at 75% probability. The main justification for selecting this particular level is that it is considered to be the rainfall that is sufficient for most agricultural pursuits in Sri Lanka, which can be taken as the type of human endeavor most sensitive to the hydro-climatic environmental conditions (Alles 1970 and National Atlas of Sri Lanka 2007). The world Food and Agriculture Organization (FAO) has also recommended 75% probability as the most suitable level to measure the reliability of rainfall in agro-economy based countries. This level has been applied in several rainfall studies in Sri Lanka (Alles 1970; Domroes 1974; Panabokke 1996; Ranasinghe 2002; Sirinanda 1970 and 1983). This 75% reliable rainfall is equivalent to the lower quartile (Q₁ or the 25th percentile) of an ascending sequence of data series and the formula can be written as follows:

$$P = m / (n + 1)$$

(Ranasinghe 2002)

Where - **P** is the probability of a series being equaled or exceeded, **m** is the order of a rainfall series and **n** is the number in the sample.

RESULTS AND DISCUSSION

The minimum and maximum CV values that have been computed on FIMS, SWMS, FIMS and NEMS for each study location, in respect to the three climatic zones of the country, are considered for the discussion (Table 1 displays only for minimum CV values of FIMS).

Minima of CV during the FIMS is mostly confined to the decade of 1961-1970 in the dry zone (73%). The first two decades demonstrated a similar highest minima of CV in the wet zone (33% for each). In the case of the intermediate zone, 67% of minima is seen to be in the decade of 1971-1980. During the SWMS, different features could be seen in the three climatic zones. The decade of 1991-2000 stands out with highest number of minima for the wet zone, while in the case of the dry zone, the highest percentage appeared in the decade of 1981-1990. During the SIMS, the occurring minima of CV in the decades of 1951-1960 and 1961-1970 are followed by the wet zone (33% for each). The dry zone has signified the decade of 2001-2010 (55%), while both the 1961-1970 and 2001-2010 decades are followed by the intermediate zone. The higher number of minimum CV values during the NEMS have been confined to the decade of 1961-1970 for all three climatic zones, representing 78%, 45% and 33.5% for the wet, intermediate and dry zones, respectively. Table 1 denotes the minimum CV values during the FIMS.

Maxima of CVs during the SWMS are different between the three zones. The highest number of stations with maxima in the wet zone corresponded in two decades; 1971-1980 and 2001-2010. However, the percentages are not that marked and represent only 27% for each. The decade of 2001-2010 was also signified by the dry zone, and denotes 45%. About 67% of maxima in CV of the intermediate zone was followed by the decade of 1991-2000. During the SIMS, for all the three zones, the majority of maxima in CV are exhibited by the decade of 1971-1980 representing 27%, 67% and 54% for the wet, intermediate and dry zones, respectively. The decade of 1981-1990 is more pronounced as having had a maxima of CVs during the NEMS, denoting 68%, 67% and 82% for the wet, intermediate and dry zones, respectively.

The minimum and maximum 75% probable rainfall value computed for the four rainy seasons for each study location, in respect to the three climatic zones of the country, are considered for the following discussion (Table 2 shows only for minimum 75% probable rainfall values of FIMS).

Table 1 - Minimum Coefficient of Variability Values during the FIMS

	Wet Zone		Intermediate zone		Dry Zone	
	Station	Value (%)	Station	Value (%)	Station	Value (%)
1951-1960	Kalutara Kekanadura Galle	37.9 37.3 29.6				
1961-1970	Undugoda Farm Kandy Nuwara-Eliya	17.3 16.7 22.2	Kurunegala	26.2	Humbantota Amparai Tank Batticaloa Trincomalee Polonnaruwa Anuradhapura Mannar Jaffna	44.4 30.3 53.5 57.3 32.6 27.7 49 47.4
1971-1980	Henerathgoda Rathnapura	24.7 17.1	Badulla Nalanda	29.3 36.7		
1981-1990	Colombo	37.4				
1991-2000						
2001-2010					Okkanpitiya Puttlam Vauvnia	26.8 37.5 34

Table 2 - Minimum 75% Probable Rainfall Values (mm) during the FIMS

Decade	Wet Zone		Intermediate zone		Dry Zone	
	Station	Value	Station	Value	Station	Value
1951-1960						
1961-1970						
1971-1980					Humbantota Batticaloa Jaffna	73.0 41.5 24.6
1981-1990	Kalutara Kandy Ratnapura Kekanadura	171 189.9 399.6 77.5	Kurunegala	303	Anuradhapura	149.3
1991-2000	Colombo Henerathgoda Undugoda Farm Nuwara-Eliya Galle	176.1 183.7 364.9 83.1 113.5	Badulla Nalanda	122.9 143.4	Okkanpitiya Amparai Tank Trincomalee Polonnaruwa Puttlam Mannar Vauvnia	139.8 34.9 28.3 27.0 103.7 41.6 79.4
2001-2010						

In terms of the minimum 75% probable rainfall, the results of the study revealed that during the FIMS, the three climatic zones are characterized with a similar pattern; the highest number of stations with the lowest reliable rainfall was demonstrated by the decade of 1991-2000 and the percentages shown were 56, 67 and 64 for the wet, intermediate and dry zones, respectively. During the SWMS, the lowest reliable rainfall was mostly confined to the decade of 2001-2010, with about 67% of the stations in the wet zone, 33.3% in the intermediate zone and 45% in the dry zone. During the SIMS, the decade of 1981-1990 demonstrated the highest number of stations with minima in the wet zone (89%) and dry zone (45%). The NEMS, too, exhibited a similar pattern to the SIMS, and the decade of 1981-1990 demonstrated 67% of minima in the wet zone and 54% of minima in the dry zone. The decade of 1991-2000 was signified by the intermediate zone (67%).

The maximum value of 75% rainfall probability of a season refers to the idea that the highest reliability of rainfall, or in other words the least variability of rainfall, within the period considered. During the FIMS, the majority of stations with maxima were found in the decade of 2001-2010, representing 44% of the wet, 67% of the intermediate and 36% of the dry zone. The three climatic zones have shown differences during the SWMS, and the decade of 1961-1970 is more pronounced for the wet zone and has covered 56% of maxima. The intermediate zone corresponded with the decade of 1971-1980 (67%) while the decade of 1991-2000 is more visible for the dry zone (36%). The decade of 1961-1970 has been signified by the SIMS, and has represented 33%, 67% and 36% of maxima for the wet, intermediate and dry zones, respectively. During the NEMS, in the wet zone, two decades (1951-1960 and 1961-1970) show a similar high percentage (44%). The decade of 1951-1960 was denoted as the highest percentage (45%) for the dry zone.

CONCLUSIONS

This study confirms that the lowest variability of seasonal rainfall is more pronounced in the decades 1951-1960 and 1961-1970, especially during the SIMS and NEMS. Relatively, the variability of seasonal rainfall is higher in the decades 1971-1980, 1981-1990 and 2001-2010, in terms of spatial distribution of decadal scale variability of seasonal rainfall, and contrasting features are marked during the SWMS. However, during the SIMS and NEMS' the wet and dry zones are mostly associated with similar patterns, while it is slightly less evident for the

intermediate zone. Finally, this study revealed that none of the rainy seasons have gone through a continuous increase or decrease in variability within the period of 1951-2010.

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INVOLVEMENT WITH AND ATTITUDES TOWARDS EXTRACURRICULAR ACTIVITIES AMONG MEDICAL STUDENTS AT THE UNIVERSITY OF SRI JAYEWARDENEPURA

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INTRODUCTION

Extracurricular activities (ECA) spreads over a vast range of fields and are found at almost all academic institutions. ECAs are the activities in which students participate, but which do not fall within the scope of the normal curriculum of an academic course or institute, eg, sports, clubs/societies and aesthetic activities.

ECAs could be further categorized into constructive and non-constructive ECAs. Non-constructive ECAs are unsupervised activities such as watching non-educational television programmes. Constructive ECAs are mostly organized activities such as sports and community services, which help enhance one's major developmental tasks. Particularly where university students are concerned, participating in constructive ECAs is highly beneficial for them as it affects positively on students' academic achievements, physical and mental wellbeing, the building of social skills and in shaping personality (Ali et al 2009). Therefore, it is very important to identify students' level of participation, attitudes and barriers towards ECAs, so necessary action can be taken by the university authorities to enhance involvement in ECAs among students.

OBJECTIVES

General objective

- To assess the involvement with and attitudes towards extracurricular activities among medical students at the University of Sri Jayewardenepura.

Specific objectives

- To describe students' participation in ECAs.
- To determine attitudes towards ECAs among medical students
- To determine the barriers that affect medical students in the participation in ACAs

METHODOLOGY

A descriptive study was carried out from September to November 2013 in the Faculty of Medical Sciences at the University of Sri Jayewardenepura. The study population in this study was a cross section of 1st, 2nd, 3rd and 4th year medical students at the Faculty of Medical Sciences. Final year medical students were excluded from the study as they could be considered to be a special cohort as they were studying full time at the hospitals and were rarely using university facilities.

Stratified random sampling was used and the sample size for the study was taken as 416. The entire sample was stratified into 4 equal parts and was allocated among 1st, 2nd, 3rd, and 4th year medical students equally. Then the sample size, which was taken from each academic year, was calculated as 104. A randomly chosen 104 students were selected from each academic year.

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Permission to conduct this study was obtained from the Dean of the Faculty of Medical Sciences after approval was obtained from the ethical review committee. Informed written consent was obtained from the participants.

A validated self-administered questionnaire was used to collect data at a convenient time at the end of lecture sessions. The questionnaire was developed by investigators and after getting the ethical approval, the questionnaire was pre-tested using 20 students who didn't participate in the main study. Relevant modifications were made to the questionnaire before it was used in the main study. The participants were asked to complete the questionnaire individually without discussing with each other and the questionnaire was collected soon after completion.

Data analysis was done using SPSS 16.0 version using the Chi square, T and ANOVA tests. Attitude analysis was done using +2 to -2 coded 5-point likert scale and a T- test was applied to the calculated mean values of the responses to find any significant positive or negative difference from value 0 (neutral attitudes). ANOVA test was used to compare significant relationships of overall attitudes with different variables (ex:-sex).

RESULTS AND DISCUSSION

A total of 385 students had responded to the questionnaire. Out of them, 148 (38.4%) were male students and 237 (61.6%) were female students. The ages of the participants ranged from 19-27 years, with the median age being 23 years. There were 96 undergraduates from first year, 90 from second year, 102 from third year and 97 undergraduates from 4th year in the study.

Level of participation in ECAs

A majority of the students (86%) had participated in some kind of an ECA. According to the results, no association could be seen between sex and participation in ECAs ($p>0.05$) among the study participants.

Table 1 - Frequency distribution by overall student participation for specific ECAs

Extracurricular Activity (ECA)	Overall Participation	
	Frequency	Percentage
Sports and games	126	32.7%
Activities in Clubs/ Societies/Groups	141	36.6%
Social services	136	35.3%
Religious activities	232	60.3%
Participate in aesthetic activities (Music, dancing, drama, drawing)	205	53.2%
Entertainment (watching TV, movies, listening to music, reading)	317	82.3%
Physical activities (Exercising ,Gym, Cycling, Jogging)	157	40.8%

The highest participating ECA among students (82.3%, $n=317$) were ECAs related to entertainment (watching TV, movies, listening to music and reading). In the same way, more than 80% of university students in London were found to have been involved in entertainment

related ECAs (McManus and Furnham, 2006). Other than that, in the current study, most students were participating in religious activities (60.3%, n=232) and aesthetic activities (53.2%, n=205). However, when the rest of the ECAs were considered, students' level of participation was low. The lowest participating ECA among students were sports and games (32.7%, n=126). According to Fredricks and Eccles (2006), 64.5% of American students participated in sport activities and when the results were compared, sports participation is much lower among students in the current study. This could be because Sri Lankan students may not have sufficient resources such as facilities, equipment and money to participate in sports and games as American students may have. Further, medical students may not have sufficient time due to their tight academic schedules.

Entertainment-related ECAs (watching TV, movies, listening to music, reading) were the most participated ECA among both males (81.1%) and females (83.1%), while male students showed the lowest participation (36.5%) in social services and females showed the lowest participation (32%) in physical activities (exercising, gym, cycling, jogging). No significant differences could be seen ($p>0.05$) in the participation in ECAs between males and females except in sports/games and physical activities. Male participation were significantly higher ($p<0.05$) than females in sports/games (male 52% and female 20.7%) and physical activities (exercising, gym, cycling, jogging) (male 54.7% and female 32%). According to Zhe (2012), in China, male students' participation in sports and physical activities were higher than female students and those results have been comparable with the current study.

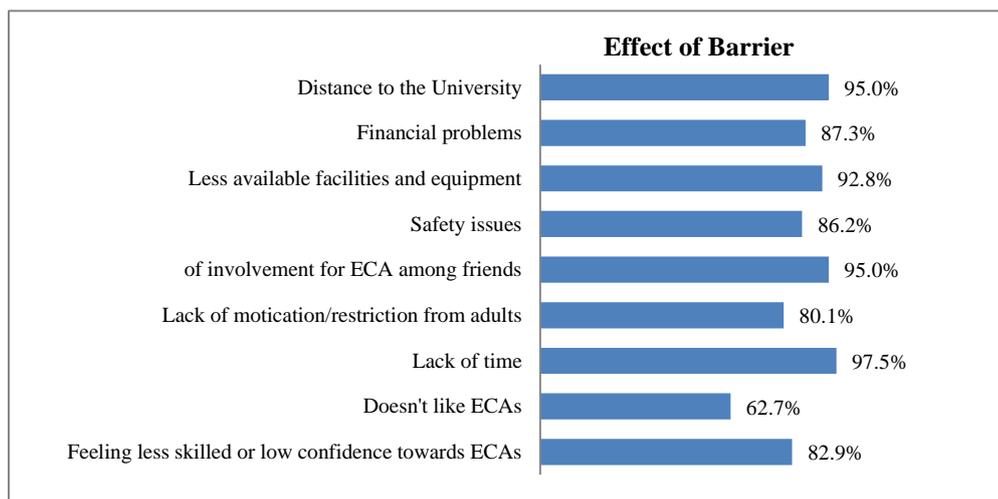
Student's regular participation in ECAs (at least several times a week) was very low except in entertainment-related ECAs (50.4%). When other ECAs were considered, only less than 5% of students had participated in ECAs on a regular basis (several times a week), except in physical activities (12.2%).

Attitudes towards extracurricular activities

Students' overall attitude towards involvement in ECAs was positive. Further, students had positive attitudes on the involvement in ECAs towards their academic performance, physical health and social well-being. However, they showed neutral attitudes on the impact of involvement in ECAs towards their mental well-being and had negative attitudes on the impact of involvement in ECAs towards their personality. Significant differences in attitudes could be seen between males and females on their attitudes towards the impact of involvement in ECAs towards physical health ($p<0.05$) and personality ($p<0.05$).

Barriers towards extracurricular activities

Chart 1 - Percentage distribution according to the effect of the barrier



The factors considered in the study were identified as actual barriers by most of the students, as they prevented them from participating in ECAs. A lack of time, distance to the university and a lack of involvement for ECAs among friends had become barriers for more than 95% students. According to the results, the least affected barrier was a lack of interest in ECAs (62.7%). Other than that, all other factors had become barriers for more than 80% of students. According to a research done by Humbert et al (2006), time barriers (family obligations, homework), perceived competence, perceived skills, friends, adult involvement, proximity, cost, facilities and safety were identified as barriers by Canadian students, which preventing participation in ECAs. By considering the above study and the current study, it is clear that students all over the world had common barriers that prevented them from participating in ECAs.

CONCLUSION

The data revealed that a majority of medical students have not participated in constructive ECAs that help students build their physical, mental and social well-being. Students' regular participation in ECAs was very low, except in entertainment-related ECAs. Even though students demonstrated an overall positive attitude towards ECAs, the lower involvement shown in structured ECAs could be due to a higher impact from barriers that students were facing when they were involved in ECAs.

RECOMMENDATIONS

The results in the study can be used as a guide by university authorities to find out factors/barriers that prevent students from participating in ECAs, and they could take proper action to minimize such factors/barriers. They could also as teach students about the advantages of participating in ECAs to improve involvement in ECAs among students.

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NURSES' KNOWLEDGE AND PRACTICES REGARDING THE NUTRITIONAL MANAGEMENT OF PATIENTS WITH NASO-GASTRIC TUBE FEEDING

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INTRODUCTION

Nutrition is one of the basic needs for human survival. Specifically, when people fall into sick, nutrition plays a vital role for their healing process. Adequate nutrition is required for patients to improve and maintain their health. Naso-gastric (NG) tube feeding is a useful method of nutritional management in patients who do not have the ability to take meals by mouth. Nutritional management refers to fulfilling the nutritional needs of patients. NG feeding is defined as the delivery of nutrition from the nasal route in to the stomach via a feeding tube (Nursing Clinical Practice Guideline, 2010). Naso-gastric tube feeding as a widely used alternative feeding method promotes patients' recovery, reduces the length of hospital stay and treatment costs, and enhances patients' immunity (Bowman et al., 2005). Nurses occupy one of the best positions to ensure adequate nutrition for patients because of their holistic caring role. Hence, nurses' adequate knowledge related to patients' nutritional management especially the naso-gastric tube feeding is essential to achieve the best practice and optimal outcomes for patients (Bourgault et al., 2007). Several studies have emphasized the importance of nurses' role in the nutritional support of patients, where it is argued that patients' nutrition forms a part of the successful nursing care (Persenious et al., 2006). But, high incidence of aspiration was reported due to incorrect positioning of patients during NG feeding (Metheny et al., 2010). Therefore, it is necessary to examine nurses' current knowledge and practices regarding NG feeding.

The purpose of this study is to examine the nurses' knowledge and practices regarding the nutritional management of patients with NG tube feeding. The specific objectives of the study are to determine the nurses' existing knowledge regarding the management of patients with NG feeding, describe the current practices of nurses in feeding patients through NG tubes, and discuss the challenges faced by nurses when practicing NG feeding procedure. The findings of the study would be helpful to provide nurses and nurse managers with an in-depth understanding of the nurses' competencies in nutritional management of patients with NG tube feeding which will help to develop appropriate guidelines.

METHODOLOGY

Quantitative, descriptive design was used for the study to assess a randomly selected sample of 150 nurses working at medical wards of the National Hospital of Sri Lanka. A self-administered questionnaire was used as the tool in collecting data. 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-retest reliability. Ethical clearance was granted from the Ethical Committee of the National Hospital of Sri Lanka (NHSL). Written informed consent was obtained from each participant prior to the study while assuring voluntary participation. The data analysis was done using descriptive statistics.

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RESULTS AND DISCUSSION

A total of 144 questionnaires were returned out of 150 representing a 96% response rate. Of the sample, majority was females (92%). Thirty percent of the sample had less than 1 year of service experience, 30% had 1-5 years of working experience while 40 had more than five years of working experience as a nurse. When considering the highest level of nursing education received, 19% were under graduate nurses and 81% were diploma holders.

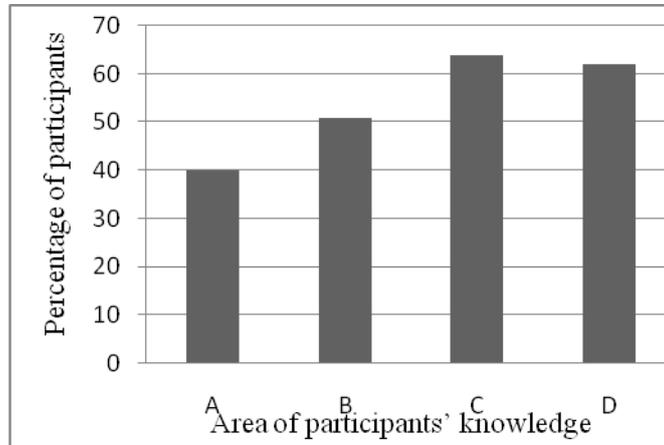


Figure 1: Nurses' existing knowledge regarding NG tube feeding

A. Knowledge on correct way of calculating the nutrition value of NG feed	C. Knowledge on preventing of complication of NG feed
B. Knowledge on proper administration method of NG feed	D. Knowledge on correct way of nutritional assessment

There was a variation in nurses' knowledge on NG tube feeding. The majority had adequate knowledge in many aspects on NG-tube feeding. According to findings, more than 60% of the participants knew how to prevent complications of NG feeding. The majority of the participants had knowledge regarding the correct way of nutritional assessment (61%), and proper administration method of feed (50%). Regarding the calculation of required value of nutrition, only 40% (Figure 1) had sufficient knowledge while many had poor knowledge, which is similar to the findings of the study by Al-kalaldehy (2011).

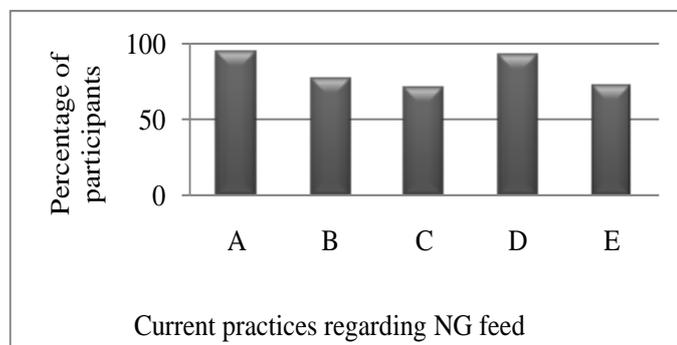


Figure 2: Current Practices among Nurses in NG Feeding

A. Confirmed tube placement before delivering of feed	D. Maintained fluid balance chart
B. Flushed tube before and after administrating feed	E. Documented complications
C. NG tube changed within regular intervals	

According to the findings, over 90% of participants engaged in the activity of confirmation of

tube placement before delivering of feed and maintaining of fluid balance charts. Nurses' current practices regarding flushing of the tube before and after administrating NG feed and documenting complications were at a satisfactory level (> 70%). Of participants 70% reflected that they have done regular tube changing practice. The finding of the study reveals that nurses are following the desired practice method in maintaining and managing NG tube feeding as indicated in figure 2. Different results were shown by a study done in Kenya (Kobe, 2006).

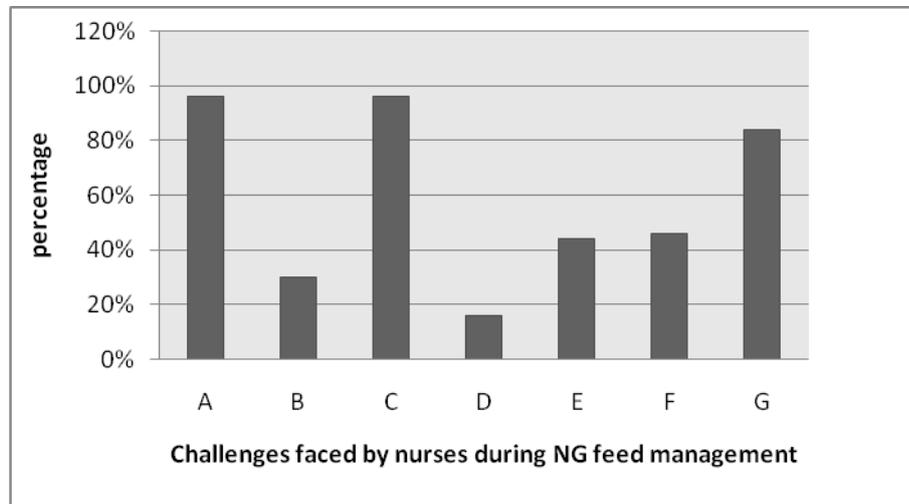


Figure 3: Challenges Faced by Nurses when Practicing NG Feeding

A. non-availability of feeding pump	E. non-availability of adequate staff
B. inadequate nutritionist support	F. lack of patients' co-operation
C. non-availability of proper guideline	G. inadequate in-service training programmes
D. non-availability of adequate feeding devices (tube/ syringes)	

The identified major challenges faced by nurses in feeding via NG tubes are: non-availability of feeding pumps (97%), non-availability of proper guidelines on NG feeding management (97%), and inadequate in-service training programs on NG feeding (82%) (Figure 3).

CONCLUSIONS/RECOMMENDATIONS

This study reveals that the nurses' knowledge vary in managing patients with NG tube feeding. Poor knowledge was reported on calculating the nutritional value of NG feed. Most nurses have followed desired practice methods of NG feeding. According to the findings, major challenges that nurses face during NG feeding are non-availability of feeding pump, lack of education programmes and guidelines for nurses in the hospital regarding NG tube feeding and its management. These findings would be helpful for the management of hospitals and nursing educators in planning ongoing education and training for nurses regarding the areas where they have poor knowledge. Further, establishing of written updated protocols/ guidelines on NG nutritional management for nurses and establishing nutritional committees for hospital would be worthwhile to ensure correct nutritional management for the patients with NG tubes. Further researches in other hospitals are also recommended for exploring knowledge and practices of the nursing staff in this regard.

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THE NEED OF A COMMUNITY HEALTH NURSE: A COMMUNITY PERSPECTIVE

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INTRODUCTION

A community is a social group living in a geographical area and / or shares common values and interests by interacting with each other (Basavanthappa, 2008). A healthy community is considered an advantage to a country because good health is a prerequisite to human productivity and development. The provision of community health care is a multi-professional team work and Community Health Nurses (CHNs) belong to one of these professions. They play a vital role in the provision of comprehensive care to individuals, families and groups of people, which contributes to the health care of the population as a whole (Basavanthappa, 2008).

Although Community Health Nursing is an integral part of the community health care system and is practiced in almost all the countries in the world, in Sri Lanka, there is no such practice. Even though Sri Lanka doesn't currently have CHNs in the field, it was practiced in Sri Lanka in the 1930s to the 1980s. In the early 1980's, the Ministry of Health of Sri Lanka decided that the Primary Health Care functions in the community could be handled by Public Health Midwives (PHMs) with the Medical Officer of Health as it is more economical to use a PHM than a nurse with 3 years training (Jayasekara, 2001). However, PHMs are trained to provide only maternal and child health care, leaving other essential aspects of care in the community, such as elderly care, disabled care, nutritional status, occupational health, at large. Although there are no CHNs currently in the community health care system in Sri Lanka, the position of the Public Health Nursing Sister (PHNS) is available, although it is a limited number of positions and their service is confined to community clinics. In the practice of Primary Health Care over the last 10-12 years, without the component of nursing at a basic level, authorities have come to realize the need for such services. Moreover, the report of the Presidential Task Force (PTF) for the development of a National Health Policy has recommended the need of introducing "community nurses" (Jayasekara, 2001). Further, with the development of new health problems in the community, it is very important to expose qualified nurses to the community.

At the same time, it is also worthwhile to explore the community perspective of having CHNs in the community as it may be helpful in making recommendations to the relevant authorities for the establishment of such a service. Therefore, this study aims to assess the community perspective about the need of CHNs in the Sri Lankan context. The specific objectives of the study are identifying the awareness of the community about existing community health nursing services, the attitudes of the community regarding community health nursing services and assessing community expectations about CHNs.

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METHODOLOGY

The quantitative descriptive design was used for this study. The study was conducted in the Kuruduwatta Gramaseva vasam which belongs to Akmeemana Medical Officer of Health area in Galle district. Simple random sampling method was used to assess a sample of 210. Written informed consent was obtained from all participants prior to data collection. Ethical approval was obtained from the Ethical Review Committee of the Faculty of Medicine, Ruhuna. A pre-tested and validated self-administered questionnaire was used to gather data. The data analysis was done by using descriptive statistics.

RESULTS AND DISCUSSION

The response rate of the study was 95%. According to the findings, the majority (75.5%) was females and the majority (48%) belonged to the 16- 30 years age group. 42% of the sample had studied up to the General Certificate of Education Advanced Level.

The majority of the sample (57.5%) was seeking care from hospitals for health conditions that could be managed at a community level, if such a service was available. Among the participants, 36% had spent over Rs. 5000 and 26% had spent Rs.1000-2000 to obtain care for health problems that are manageable at community level, thus making it a considerable economic burden to them.

Table 1: Awareness of the community regarding existing community health nursing services

Factors	Aware		Not Aware		No Idea	
	N	%	N	%	N	%
Availability of maternity clinics	187	93.5	02	01.0	09	04.5
Availability of well-woman clinics	120	60.0	24	12.0	48	24.0
Availability of school health programmes	129	64.5	28	14.0	34	14.0
Availability of screening services for chronic diseases at well woman clinics	91	45.5	17	08.5	78	39.0
Public Health Sister's participation at maternal, child and well-woman clinics	109	54.0	28	14.0	84	42.0
Awareness of nurses duties	150	75.0	28	14.0	11	05.0

The study revealed that 54.5% of the sample was aware that the Public Health Nursing Sister (PHNS) is a member of the community health team. Among the participants, 93.5% were aware of the availability of maternal clinics, 60% was aware of the availability of well-woman clinics and 64.5% was aware of the availability of school health programmes in this area, and that the PHNS participates in those clinics and programmes. Only 45.5% of the participants knew that non-communicable diseases are screened at well-woman clinics with the participation of a PHNS and that a referral system is available for those required such a service (Table 1). According to the Annual Health Bulletin, the PHNS supervises the Public Health Midwives and attends in the health care programmes and clinics (Ministry of Health, 2008).

The majority (75%) of participants were aware of the services of CHNs, if available, based on their knowledge and experiences of the services of nurses working at hospitals (Table 1). The identified possible services that can be provided by nurses at community level were measuring blood pressure, drawing blood for investigations, removing sutures, wound

dressing, catheterization and feeding via nasogastric tubes. According to Jayasekara (2001), the role of the nurse may include a unique mix of nursing activities such as catheterization, the management of intravenous infusions and injections, wound care management, nutritional management, health education and counseling.

Table 2: Attitudes of the community on the community health nursing service available in the Akmeemana MOH area

Factor	Yes (n)	Yes (%)
Establishing of a free community health nursing service will not be difficult	129	64.5%
Prefer to have CHNs in the field	200	100.0%
Establishing of a free home nursing service will not be difficult	108	54.0%
Available community health service is insufficient	80	40.0%

All the participants (100%) of the study recommended that a qualified, responsible health professional should be available in the community to address their health problems at the home level. Moreover, 40% of the sample was not satisfied with existing community health services. This response indicates that there is a great need for such a service in the community.

The study further revealed that all the participants desired to have CHNs which is in line with the findings of the study by Hohl (1994). 90% of the study sample identified that nurses as qualified health care providers. Jayasekara (2001) states that the CHNs could provide home care to the sick and disabled, assess and help resolve community health problems through the education of individuals, families and communities regarding illness prevention, disease control and health promotion.

If CHNs are available, 70% of participants expected these nurses to have good qualities, such as kindness, patience, knowledge, humbleness, understanding of human feelings, friendliness, efficiency, decision-making ability, honesty, activeness, ability of listening and treating all equally. Further, they expected that CHNs should be knowledgeable and well-experienced. Laferriere (1993) reveals that public satisfaction with home nursing services, which are integral parts of community health nursing, is based on four major factors which are a) technical quality, b) communication, c) personal relationship between client and provider and d) delivery of services.

According to the findings, the advantages of having CHNs are the ease of accessing health services as CHNs will conduct home visits (43%), the possibility of saving money that is spent unnecessarily for minor ailments (37%), the ability to obtain health advice and thereby improve health (38%), the detection of health problems early (23%), the ability to resume care after being discharged from hospitals (94%), the ability to obtain assistance to care for chronic, bed-ridden patients (93%) and the ability to reduce the number of hospital admissions (29%). Hohl (1994) states that most patients prefer to receive needed care in their homes and that currently one of seven Americans needs a home health service. According to Jayasekara (2001), it is useful to have community health nursing services in rural communities who are located far away from health facilities.

41% of the participants believed that it is difficult to establish a free home nursing service in Sri Lanka as they believed that “there is not enough nursing staff to establish a community health nursing service”. Further, some (4%) believed that it is expensive to establish such a service as they believed that “it would be an extra expense to the government”. Further, some participants believed that “the nurses may not willing to come home by home” as the reason for difficulty in establishing free home nursing service in Sri Lanka.

CONCLUSIONS/RECOMMENDATIONS

According to the findings of the study, the majority of the study sample believed that having nurses in the community setting is worthwhile as the community had a positive impression about nursing services. The community was aware about the nurses' possible services in the community setting. The community expected good qualities from community nurses in order to them to obtain safe, effective and efficient service.

Therefore, the findings of this study suggest that it is better to commence a community health nursing service in Sri Lanka as it will be a good investment for the well-being of the people of the country. It is recommended that it will be important to look at the community health practices in other developed countries as examples, before commencing such a practice in Sri Lanka. Moreover, the establishing of a well-formalized educational system for the preparation of CHNs, to give them the ability to meet the diverse demands in the community, is recommended. The nurses should also be encouraged to get involved within the community as it would be a strange initiative to Sri Lankan nursing field at first. Further research in this field, which would cover a larger population in different parts of the country, is also recommended to obtain a clear picture of community expectations of having a community health nursing service.

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IMPACT OF MATERNAL BODY MASS INDEX AND MATERNAL WEIGHT GAIN ON INFANT BIRTH WEIGHT

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INTRODUCTION

Maternal Body Mass Index (BMI) and maternal weight gain are crucial factors for fetal outcomes. BMI is a number calculated that as a person's weight (Kg) divided by the square of height (m²). It is a fairly reliable indicator of body fat for most people (Rasmussen & Yaktine, 2009). Maternal weight gain is defined as the amount of weight gained throughout the pregnancy. Birth weight is the first weight of the baby, taken just after he or she is born (Wimalawansa & Wickramanayake, 1987).

Inadequate weight gain of the mother during pregnancy is closely associated with low birth weight and excessive gestational weight gain results in adverse fetal outcomes including still birth, fetal distress and higher birth weight in developing countries (Kalk *et al.*, 2009). The effect of maternal weight gain on pregnancy outcomes depends on the women's pre pregnancy BMI (Crane *et al.*, 2009). Maternal BMI and maternal weight gain had fallen with parity and increased significantly with per capita family income and the level of education of the mother (Wimalawansa & Wickramanayake, 1987).

In Sri Lanka the Low Birth Weight (LBW) rate was 17.6% in 2008. It was 14.3% in the North Central Province (NCP) in the same year (Ministry of Healthcare and Nutrition, 2008). According to hospital statistics, out of 11,560 live births, 1966 births were found to having LBW in the year 2011 in the Anuradhapura and Kurunegala Districts (Ministry of Health 2012). Therefore this study aims to identify the impact of maternal BMI and maternal weight gain on infant birth weight and examine the factors affecting the same.

METHODOLOGY

The quantitative, descriptive design was used for the study to assess a purposive sample of 154 mothers who delivered babies at post natal wards in the Teaching Hospital, Kurunegala and Base Hospital, Kuliyaipitiya. A questionnaire was used as a tool for data collection in this study. Content validity of the questionnaire was assured by the researcher's supervisor, co-supervisor and experts in the relevant field. The reliability of the questionnaire was assured by pre testing with post-natal mothers who did not participate in the study. Ethical clearance was granted by the Ethical Review Committee of the Teaching Hospital Kurunegala. Written informed consent was obtained from each volunteer participant prior to the study. Data were analyzed using descriptive statistics

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RESULTS AND DISCUSSION

The response rate of this study was 96% (n = 154). Among participants of the study were females and 154 (response rate was 96%) respondents consisting of 75 from the Base hospital Kuliyaipitiya and 79 from the Teaching Hospital Kurunegala.

Table 1. Distribution of age and birth weight of mothers

Weight gain Age of mother	Below range	Normal range	Above range
Teenage (below 19yrs)	4 (33.4%)	8 (66.6%)	0
19-35 yrs	68 (55.7%)	34 (27.8%)	20 (16.5%)
Over 35 yrs	4 (20%)	4 (20%)	12 (60%)

The majority of the sample (79.2%) belonged to the 19-35 years age group and 7.8% and 13% were below the 19 years age group and the 35 years age group respectively. In relation to age, the majority of teenage mothers (66.6%) belonged to the normal range while 33.4% of these were in the weight gain below range. However, the majority (60%) of mothers who were over 35 years belonged to the above weight gain group (Table 1). This study implies that when women become over age there is a high possibility to gain more weight than recommended during the pregnancy. This finding is positively supported by Abrams *et al.* (1995) in California.

Participants who had a diploma level education, maintained a normal BMI whereas mothers who had studied up to grade 10 were prone (45%) to have an obese level BMI. Therefore this study conveys that there was a significant effect of education level on maternal BMI. Similar findings were highlighted in Yekta *et al.*, (2006).

Table 2. Distribution of infant birth weight according to mother's BMI

BMI of mother Infant birth weight	Underweight (BMI<18.5)	Normal weight (BMI≥18.5 and <25)	Overweight (BMI ≥25 and <30)	Obese (BMI ≥30)
LBW (<2500g)	4 (12.6%)	22 (27.5%)	0	0
NBW (≥2500 - ≥3500g)	26 (81.2%)	58 (72.5%)	20 (100%)	12 (54.5%)
HBW (>3500g)	2 (6.2%)	0	0	10 (45.4%)

LBW- Low Birth Weight; NBW- Normal Birth Weight; HBW- High Birth Weight

In the study, participants were divided into four main categories depending on their BMI namely, underweight, normal weight, overweight and obese. Data showed that all babies born to overweight mothers had normal weight. Nearly 50% of babies, born to obese mothers had normal weight and the rest of the babies were in the high birth weight category. Mothers with normal BMI had normal birth weight babies reported as 72.5% and 81.2% of underweight mothers had normal birth weight babies. Among mothers with normal weight, there were nearly twice the number of LBW (27.5%) babies than underweight mothers (12.6%)(Table 2). Hence, this study highlights that low maternal BMI does not impact on infant birth weight but high maternal BMI had an impact on infant birth weight. But this was contradictory to studies done in Iran (Tabriz & Saraswathi, 2009) and German (Kalk *et al.*, 2009).

The findings showed that 83% of high birth weight babies had been delivered by obese mothers who had weight gain above the normal range. With respect to the research data, 89% of low birth weight babies were delivered by normal weight mothers. Among them 45% and 11% contributed to the category of “gain below range” and “gain above range” respectively. The percentage of low birth weight babies for overweight mothers was zero and results

showed that they had only normal birth weight babies. According to findings of this study a distinct relevance of the low weight gain of the mother and the possibility of producing a low birth weight child could not be observed. However, in contrast the results showed with regard to an increase in weight gain, thus there is a chance to deliver high birth weight babies. This idea was supported by Tabrizi and Saraswathi (2009).

Wimalawansa and Wickramanayake (1987) have highlighted that, there was a fall in weight gain with increasing parity. Similarly the results of the current study captured that weight gain below ranges of parity 01(having one child), there were 10 out of 16 under weight mothers, 8 out of 34 normal weight mothers and no overweight mothers. However weight gain below ranges of parity 02 (having two children) included all mothers (14) in the underweight group (Table 3).

Table 3. Distribution of infant birth weight according to maternal weight gain and BMI

Maternal BMI	No. of LBW	No. of NBW	No. of HBW	Maternal BMI	No. of LBW	No. of NBW	No. of HBW
Underweight (BMI<18.5)				Over weight (BMI≥25 & <35)			
Gain below range	2(11%)	24(19%)	2(17%)	Gain below range	-	8(6%)	-
Gain normal range*	-	4(3%)	-	Gain normal range*	-	6(5%)	-
Gain above range	-	2(2%)	-	Gain above range	-	-	-
Total	2(11%)	30(24%)	2(17%)	Total	-	14(11%)	-
Normal weight (BMI≥18.5 & <25)				Obese (BMI≥35)			
Gain below range	8(45%)	34(27%)	-	Gain below range	-	2(2%)	-
Gain normal range*	6(33%)	18(15%)	-	Gain normal range*	-	6(5%)	-
Gain above range	2(11%)	12(10%)	-	Gain above range	-	8(6%)	10(83%)
Total	16(89%)	64(52%)	-	Total	-	16(13%)	10(83%)

*Referance Ranges- Normal Weight Gain according to mother’s Body Mass Index (BMI) BMI<18-12.6-18kg, BMI≥18.5&<25) -11.25-15.75kg, BMI≥25 & <35 - 6.75-11.75kg, BMI ≥35 - 4.95-9kg

With regard to the nutritional status of the sample (Figure 1) 96.1% was non-vegetarian while 3.9% were vegetarian. All vegetarians were underweight. Moreover, over 95% of overweight and obese mothers had taken various type of food like starchy, protein, sweet and fatty food frequently. Thus it seems that the nutritional status of the mother directly affected the mother’s BMI as well as weight gain during pregnancy. These findings were supported by Wimalawansa and Wickramanayake (1987).

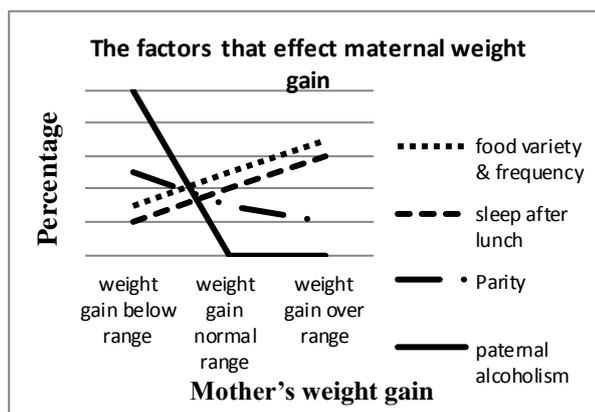


Figure 1 – Factors affecting maternal weight gain

According to the findings of this study it is highlighted that 72% of normal weight gain mothers slept after lunch and 100% of over weight gain during pregnancy of obese mothers slept during the day. Nedeltcheva *et al.* (2009) also discussed the effects of sleep on weight gain during pregnancy.

CONCLUSIONS/RECOMMENDATIONS

The findings of the study point out that low maternal BMI or low maternal weight gain may not lead to low birth weight, whereas high maternal BMI or high maternal weight gain has positive influence on high birth weight. Low level of education, over-age, high frequency of food consumption were identified as factors that lead to high maternal BMI and high weight gain. Parity directly impacted on low maternal weight gain.

The findings of this study could be implemented in maternity care in nursing practice as it enhances the current knowledge of nursing and midwifery education. Further findings would be useful to improve the knowledge of expecting mothers. As this study was restricted to the Kurunegala and Kuliyaipitiya Hospitals, the researchers recommend that further studies be carried out in other parts of the country.

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USE OF CONTRACEPTIVES AMONG MOTHERS DURING FIRST YEAR AFTER THEIR FIRST DELIVERY

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INTRODUCTION

Contraceptives are drugs, devices or practices used to prevent a woman becoming pregnant. It is a part of family planning and it can contribute to maternal and child survival (Magowan *et al.*, 2009). Modern contraceptive methods which include male and female sterilization, Intra Uterine Devices (IUDs), implants, injectables, pills, male and female condoms and spermicides are highly effective in preventing pregnancy rather than traditional methods, such as male withdrawal and periodic abstinence (Singh & Darroch, 2012). Women's knowledge about various contraceptive methods together with their decision whether to have a child or not, and their personal preferences can influence the occurrence of a pregnancy (Cwiak *et al.* 2004).

After a live birth, the recommended interval before attempting the next pregnancy is at least 24 months in order to reduce the risk of adverse maternal, peri-natal and infant outcomes (World Health Organization, 2005). In Sri Lanka, insufficient spacing between consecutive births is one of the main reasons for seeking abortion (Rajapaksha, 2002). The risk is greater among first time mothers who do not know what to expect after their first delivery and they rely on the advice and explanations of their female relatives, neighbours and friends (Salway & Nurani, 1998). It is estimated that one in three deaths related to pregnancy and childbirth could be avoided if all women had access to contraceptive services (Singh & Darroch, 2012).

The number of mothers attending antenatal clinics and who get pregnant within one year after their first delivery, is increasing remarkably. However, there are only a few studies done on this matter. Hence, this study was carried out with the main purpose of examining the use of contraceptives among mothers during the first year after their first delivery, who were attending antenatal clinics and antenatal wards at the De Zoyza Maternity Hospital for Women, Colombo (DMH). This study was carried out with the specific objectives of identifying the mothers' knowledge, attitudes, and practices and to identify the perceived barriers to the use of contraceptives.

METHODOLOGY

A quantitative descriptive study was conducted. Mothers, who were pregnant within the first year after their first delivery, attending the antenatal clinics and antenatal wards at the DMH were included in the study. Data were collected during December, 2013 to February, 2014. The purposive sampling method was used to include 153 participants (N=153). A self-administered questionnaire was used as the data collection tool and it was given after obtaining informed written consent.

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The questionnaire was pre-tested with ten pregnant mothers who were not included in the study sample. The questions were directed towards gaining information on participants' demographic data, knowledge, attitudes, practices and perceived barriers regarding the use of contraceptives. Descriptive statistical methods were used to analyze the collected data and Microsoft Excel package was used to calculate the percentages. Ethical approval was granted by the Ethical Review Committee of the DMH.

RESULTS AND DISCUSSION

Demographic characteristics

The majority 32% (49) of participants were in the age range of 26-30 years. Participants who had been educated up to General Certificate of Education (G.C.E.) Ordinary Level (O/L) 43% (66) and up to G.C.E. Advanced Level (A/L) 28% (43) were higher than participants who had been educated up to degree or higher education 5% (8). Majority 62% (95) of the participants were unemployed while the family income of 38% (58) of the participants was over LKR.40,000.00

Knowledge and attitudes regarding the use of contraceptives

According to the findings, overall knowledge level of participants was identified as excellent, good, average and poor as 24%, 47%, 22% and 7% respectively. The majority of participants (96.7%) had heard about contraceptives. More than 80% knew about the Oral Contraceptive Pills (OCP), Intra Uterine Contraceptive Devices (IUCD), Depo-Provera injections, and condoms (Figure 1). Similar results were shown by Kariuki *et al.*, (2011). IUCD was selected by 83% of participants as the most suitable method to use in the first year after the delivery. More than half of the participants accepted "six weeks" as the most suitable time period to start contraceptives after a delivery. However, 41% of participants were unaware of the most preferable contraceptive method after a delivery, similar to the findings of Rahmanpour *et al.*, (2010) in Iran.

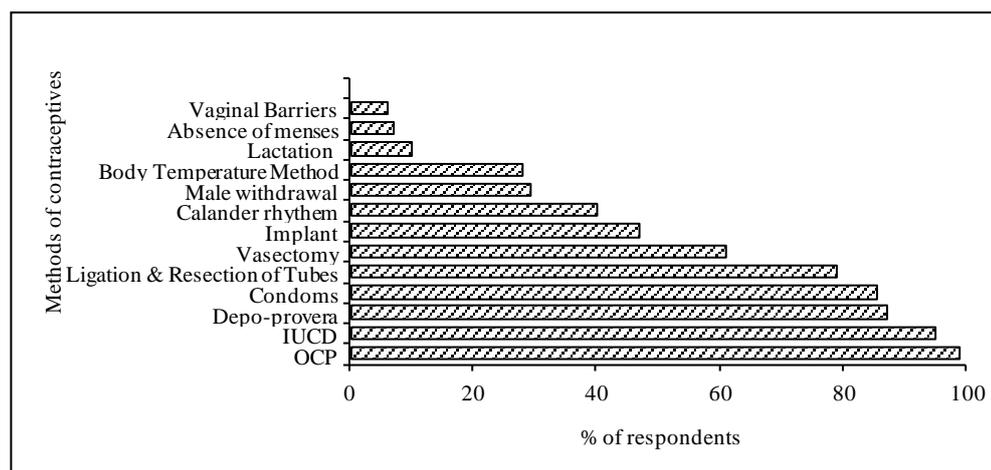


Figure 1: Mothers' knowledge regarding contraceptive methods.

The overall attitude level of participants was identified as excellent, good, average and poor as 8%, 11%, 73% and 7% respectively. The majority of participants (93.5%) agreed that it is necessary to keep a gap between pregnancies at least two years while 75% believed that it is possible to get pregnant during the breast feeding period, and 62% agreed that contraceptives are not very expensive. However, more than half of the study group (56.2%) believed that the contraceptives are not very effective. Further 55% agreed that contraceptives which contain hormones can affect their body image considerably. These ideas were supported by the findings of Mustafa *et al.*, (2008).

Practices and major barriers to use of contraceptives

More than half of the study group (68%) had not practiced any method of contraception after their first delivery (non-users). Among them, the majority 35% (36) had not used contraceptives due to their negligence and 2% (7) due to the expectation of another child (Figure 2). A similar result was found in Nigeria (Monjok *et al.*, 2010). Among the participants who had used contraceptives after their first delivery (users), 71% had used contraceptives to keep the gap between the births while a minority 10% due to economic problems.

Among the contraceptive users of this study, the most used method was identified as IUCD (32.7%) while the male withdrawal method (4%) was the least used method. Contrasting results were found in Kenya where the most popular methods used by the mothers were identified as injectables and OCPs (Kariuk *et al.*, 2011). From those in our study who had used contraceptives after their first delivery, their main source of information was health personnel (71%). This may be due to the free health services provided by the Sri Lankan government. The sources of information of a minority of participants were media, friends and relatives, which is in contrast to the findings of Jabeen, *et al.*, (2011).

Major barriers to the use of contraceptives were identified as fear of side effects (25%), lack of information (23%), and misinformation (20%). Contrasting results were shown in a study done in Nigeria, by Ankomah *et al.*, (2013) where the major barriers to using contraceptives were economic reasons at the family level and lack of support from the husbands.

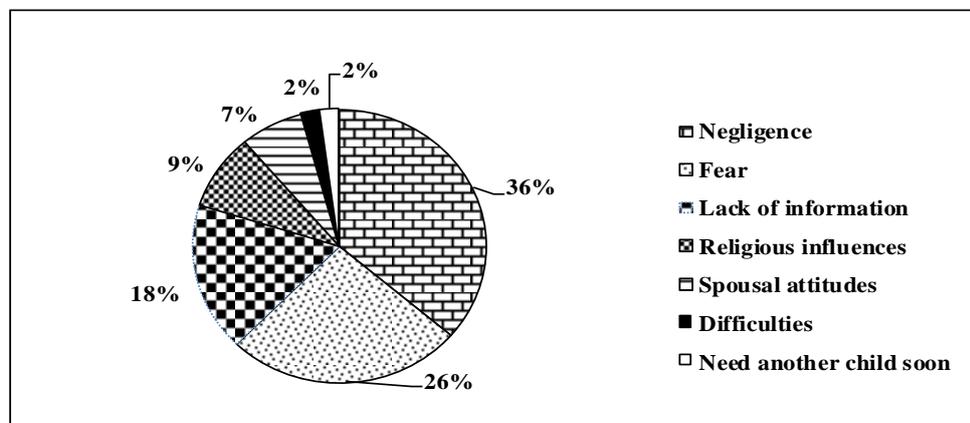


Figure 2: Reasons for not using contraceptives after first delivery

CONCLUSIONS/ RECOMMENDATIONS

The study revealed that the majority of mothers had a good level of knowledge of contraceptives. But most of them were not aware of the suitable methods of contraception during the first year after first delivery. Further, the majority of the participants had an average level of attitudes. The use of contraceptives during the first year after the first delivery was very low mainly due to negligence and fear of side effects. The most used contraceptive method among the participants was identified as IUCDs. The barriers to not using contraceptives were identified as fear of side effects, lack of information, misinformation, and myths and beliefs.

The study identified health personnel as the most reported source of information about contraceptives. The health personnel can play a positive role to provide knowledge and overcome the knowledge-practice gap of using contraceptives among the mothers who are in the first year after their first delivery.

Finally this study recommends increasing the use of contraceptives among mothers by providing adequate information, support and access to services, and intervention should be aimed to counter negative perceptions of contraceptives. Further a follow-up appointment with the health care providers should be arranged for all first time mothers after being discharged from the hospital after their delivery to discuss the spacing of the next pregnancy.

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EFFECTIVENESS OF THE PROGRAM OF DIPLOMA IN NURSING AT OUSL: DIPLOMATES' PERSPECTIVE

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INTRODUCTION

The world population recorded the 07 billion mark at the end of the first quarter of 2012. Along with this recorded increase of the world population, health concerns are increasing (Population Reference Bureau, 2013). Further, as a result of advances in science and technology in the world context, health care needs have become more complex with population increments, which have required more comprehensive Home Nursing and Community Nursing services. Hence, today's professional nursing practice faces challenges derived from advances in science and technology, an increased level of patients' acuity, and identified issues related to patients' safety in emerging societies. Therefore, it is necessary to produce more knowledgeable and skillful nurses to face these challenges in fulfilling social demands.

Considering this necessity, nursing education is provided by both formal and informal ways in the Sri Lankan health care system. In this regard, the Health Ministry and national universities provide formal nursing education facilitating capacity building within the nursing profession. However, a review of the Sri Lankan health care delivery systems identified that a considerable shortage of qualified nurses still exist in almost all medical institutions, in both private and public settings.

The inadequate recruitment of students into state nursing schools, universities, other private institutions, and limited facilities to educate nurses has been promulgated as a factor in the shortage of qualified nurses within the country. The Open University of Sri Lanka (OUSL) identified this need and developed the program "Diploma in Nursing", in collaboration with Hemas Hospitals Private Limited in 2011, to produce more highly competent nurses. Being the very first batch of its kind the Diploma in Nursing 2011 batch of students of the OUSL might have experienced successes as well as potential challenges to be addressed in the future. Therefore, it is a timely need to conduct an ex post facto study to ascertain the diplomates' experiences of being a part of the student population of the OUSL Diploma in Nursing. Accordingly, this survey was carried out to ascertain the effectiveness of the Diploma in Nursing program at the end of the studies of the first batch of students.

METHODOLOGY

This ex post facto study was conducted at the OUSL premises for 29 students. A validated, self-administered questionnaire was used to collect data. The first part of the questionnaire focused on the participants' general satisfaction at the university, the second part sought to identify students' satisfaction with the programme and the third part attempted to identify students' satisfaction with lecturers' contribution to the program. Further, the fourth part sought to identify students' satisfaction about the Open Distance Learning (ODL), the fifth part focused on the participants' satisfaction with facilities and services, and the final part of the questionnaire sought to obtain students' perception about recognition from employers and patients. Data was collected during February 2014. The response rate was 100%. Data was analyzed by descriptive statistics using SPSS 16.0.

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RESULTS AND DISCUSSION

The majority of the diplomates represented were females (68.9%).

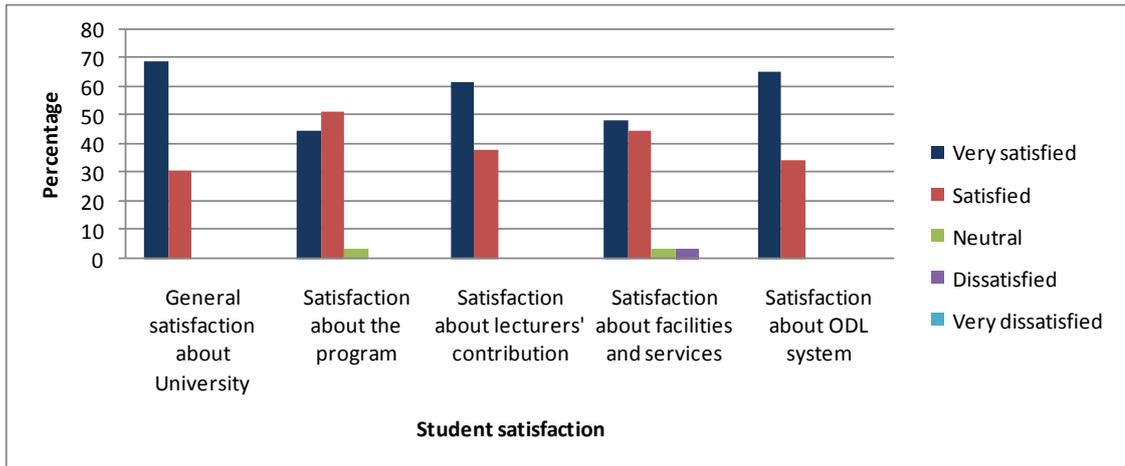


Figure 1: Students' satisfaction

The majority of the diplomates (69%) were very satisfied about the general experience obtained from the University. Further, they were very satisfied about lecturers' contribution (62.1%) to the program and with the ODL system (65.5%). A study conducted by Purdy *et al* (2011) identified that diplomates' general experience about the university and lecturers' contribution to the program was not at a satisfactory level. This result is not consistent with the present study as these OUSL diplomates demonstrated a high level of satisfaction with the general university experience and lecturers' contribution. This result might be due to students' positive perception about the academic experience and the social experience at the university.

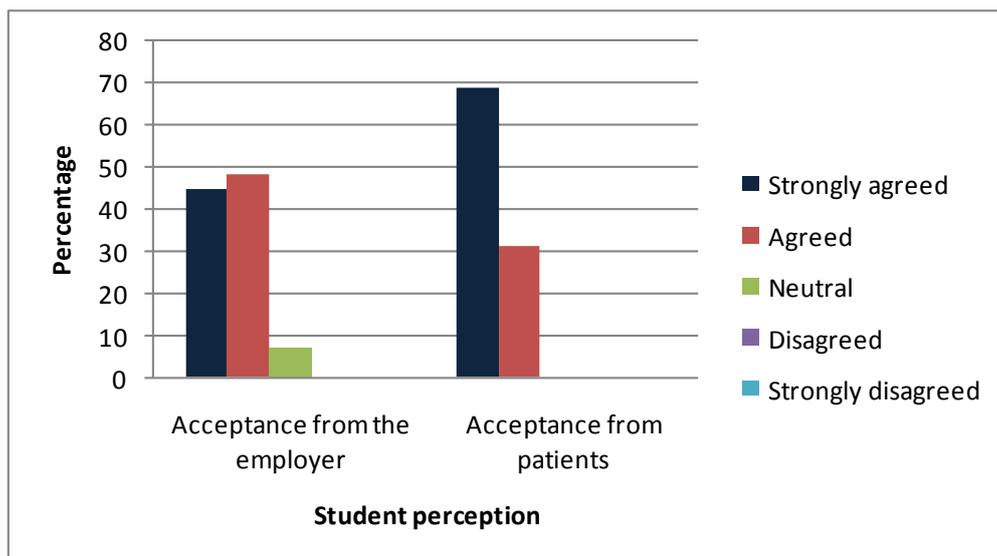


Figure 2: Students' perception regarding acceptance from the employer and patients

A majority of diplomates (69%) strongly agreed that they are accepted by patients. However, only 44.8% strongly agreed that they are accepted by the employer, too. This might reflect that patients may feel that they will receive better care from OUSL diplomates.

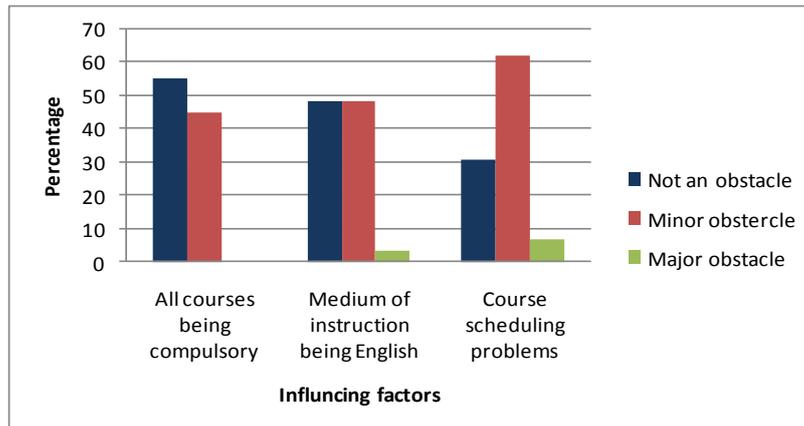


Figure 3: Influencing factors that hinder learning

According to the results, 44.8% of diplomates mentioned that being enrolled in all courses compulsorily was a minor obstacle for them. However, all courses being compulsory is vital as students should learn all the core nursing courses at the standardized general diploma level. Further, 48.3% stated that the medium of instruction being in English was a minor obstacle. Even though 48.3% stated that the medium of instruction was a minor obstacle, almost half of the participants stated that it was not an obstacle. Importantly, 62.1% mentioned that course scheduling problems was a minor obstacle to follow the program successfully.

Many diplomates identified the clinical practice that they obtained from the military hospital and the strategies that were used to enhance students' knowledge as the major strengths of the program. However, 34.4% of the diplomates highlighted the lack of clinical practice and the lack of complexity of clinical exposure as the major weaknesses of the program. These lacks may be due to the tight course scheduling of the program and a lack of the courtesy by the government to the university in providing the facilities in a clinical setting.

CONCLUSIONS/RECOMMENDATIONS

A majority of the diplomates were very satisfied with the general experience obtained from the university. In fact, the diplomats were very satisfied with their social and academic experience and lecturers' contribution to the Diploma in Nursing program. Further, it was found that it was necessary to minimize course scheduling problems to facilitate students' learning.

This ex post facto study results recommend that it is necessary to increase clinical practical opportunities and the time duration of such opportunities for diplomates. Additionally, this survey suggests that it is necessary to evaluate the academic success of the program. However, when considering the areas that students found unsatisfactory, which was clinical exposure, steps need to be taken to discuss this issue with the Ministry of Health and the Department of Health Services in terms of expanding students' clinical exposure within public sector hospitals.

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PATIENTS' EXPERIENCES OF MECHANICAL VENTILATION

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INTRODUCTION

Mechanical ventilation is a supportive therapy to facilitate the gas exchange of the lung by using a mechanical apparatus when there are impaired breathing situations. It is the most widely used life supportive technique in Intensive Care Units (ICUs) in hospitals all over the world. Despite the dramatic development in technology of the mechanical ventilator, it is still described as a stressful and frustrating experience for patients (Granja et al., 2005). Since the early days of the iron lung machine to a modernized ventilator, different studies have been conducted on patients' experiences of mechanical ventilation. Many of them highlighted these mechanically ventilated patients' experiences as very stressful. While on the mechanical ventilator, patients were mostly not unconscious, but paralyzed with medicine. Therefore, mechanically ventilated patients are undergo various experiences which are unique to each, including pain, lack of peace, fear, anxiety, lack of sleep, feeling tense, and inability to speak or communicate, (Arabi & Tavakol, 2009; Guttormson, 2011; Rotondi et al., 2002). However, in the Sri Lankan context, there are few studies related to this area.

The main purpose of this study is to examine patients' experiences of mechanical ventilation in the National Hospital of Sri Lanka, the Teaching Hospital in Peradeniya and the District General Hospital in Nuwaraeliya. Further, the study was guided by the following specific objectives: identify patients' intrapersonal experiences, extra personal experiences and interpersonal experiences during mechanical ventilation. Therefore, by exploring these experiences it will contribute to create a better awareness among the health care workers to improve quality care and interventions in managing the stressful experiences of the mechanically ventilated patient.

METHODOLOGY

The study was conducted in the ICUs of the National Hospital of Sri Lanka, the Teaching Hospital at Peradeniya and the District General Hospital at Nuwaraeliya, between December 2013 and January 2014. Under a qualitative approach and phenomenological design, a purposeful sample containing 15 participants was selected from among patients who were being mechanically ventilated for a minimum period of 24 hours; between the ages 16 to 85; who were not in a confused state at the time of the interview; had the ability to speak Sinhala, Tamil or English languages; willing to discuss their feelings; and competent with the ability to sign an informed consent. Any patient who had a tracheostomy or was hemodynamically unstable at the time of the interview was excluded from the study. Further, there were eight females and seven male participants included in the sample. Ethical approval was obtained from the Ethical Review Committee of the National Hospital of Sri Lanka and; the Ethical Review Board of the Faculty of Medicine at the University of Peradeniya. All the participants were informed that their involvement was completely voluntary and of the ability to withdraw

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from the study at any time without any penalty. Before, the data collection, permission was obtained from the directors of the respective hospitals.

Semi-structured, in-depth interviews, based on a topic guide were utilized for the exploration of the study task. All the interviews were audio taped, labeled with a specific code and secured within the research team to ensure the anonymity of the participants. A qualitative thematic analysis method was used for data analysis. Interviews were transcribed into texts. The transcripts were categorized and mapped on the basis of recurring sub themes; themes and major themes. The validity of the study was ensured by using a topic guide to discuss a similar range of topics with each participant and conducting the coding function by two members of the research team

RESULTS AND DISCUSSION

Using the generated 12 sub themes and 03 major themes, a model which illustrates how the experiences of mechanically ventilated patients affect their comfort and satisfaction was created. (Figure. 1)

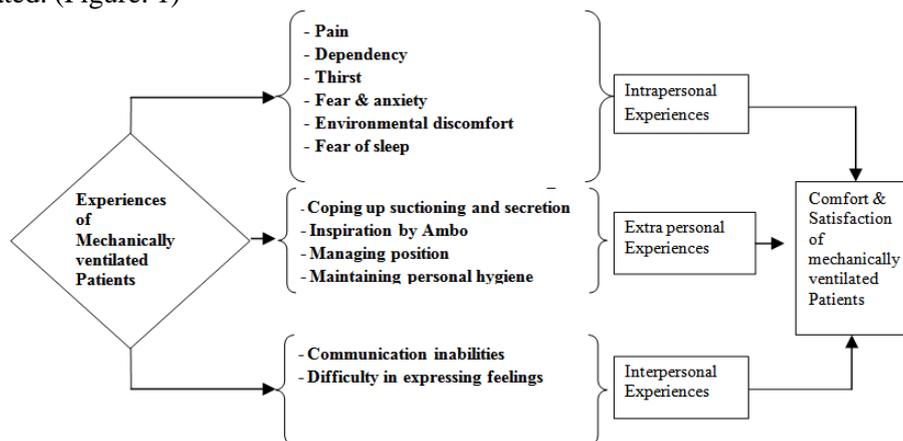


Figure.1 Mechanically ventilated patients' experiences and the experienced by them.

The patients, who had undergone ICU care with supported mechanical ventilation, are having various experiences. These experiences can be categorized mainly as intrapersonal experiences, extra personal experiences and interpersonal experiences.

Intrapersonal Experiences

There is a mixture of intrapersonal experiences and the most distinct experience among them was pain and dependency.

This was expressed by patients I and F as follows;

It was pricking like a mass of iron strings. When the tube was removed, I sort of regained life. When moving on to a side, it pricks. When on upright position, it is ok. I was not in a position to turn. It was unbearable. My back was irritating. I just obeyed the instructions to turn. I continued to be turn as instructed, even though it pricked. (Interview 09; participant I).

There was a terrible back pain. Do you remember Miss? I needed you to help me with a pillow at the back. A severe pain came; I couldn't turn even. (Interview 06; participant F).

The experience of pain during mechanical ventilation is combined with sore throat related to the endo-tracheal tube and the pain in the back due to the inability of moving their body. Both Sri Lankan and some Iranian patients similarly complained of pain in the throat and body (Arabi & Tavakol, 2009) and it may have been caused owing to the inability to change position (Tosun et al., 2009) due to the high dependency of the patients.

Feeling thirst was another major problem with mechanically ventilated patients. Participant D expressed the intensity of this feeling;

Thirst was there, I had an unquenchable thirst. I just wanted to drink a pot of cold water.

My lips were dry and when they wet my lips, it was so comforting. (Interview 04; participant D).

This might have happened due to the fact that most patients are not informed of why water is not permissible while they are on the ventilator. It could be also justified by the fact that nurses and other health care workers dismiss patients' communication efforts (Patak, et al., 2004). Further analysis reveals thirst as one of the most discomforting factor in this study, not only in Sri Lanka but also in Iran (Arabi & Tavakol, 2009).

Connected to a machine and breathing with the help of a machine is a dreadful experience that patients have while on the mechanical ventilator. Fear and anxiety associated with this experience recurrent with the experiences of the participants of the study.

I long to be seen on the faces of the little one. I saw the elder daughter. I hoped to see the younger one also. How many days were they without me? I remembered all my children. I was worried and disappointed. When the tube was made away it was comfortable and I was happy. (Interview 09; participant I).

According to the descriptions it was very stressful, and similar results were found in the studies of Patak, et al. (2004). It could be due to the fact that nurses and other health care workers dismiss the patients' communication efforts (Patak, et al., 2004).

The sounds of alarms and the mechanical noises in the ICU are a bad experience and negatively affect the comfort of the patients. Also, the cold environment in the ICU, makes the patients more uncomfortable.

The alarm was very irritable. It was intolerable at times. (Interview 04; participant D).

The AC was unbearable. I have phlegm. That's why I think. (Interview 07; participant G).

The discomfort occurs, because these environmental reasons are very stressful same as in Sweden (Johansson, Bergbom & Lindahl, 2012). It may also be caused by the unfamiliar environment.

The unpleasant experiences and difficulty to sleep is another horrific situation that the mechanically ventilated patients undergo and it is depicted through the expressed feelings of the participant I.

I couldn't sleep from the day I came. If I sleep, I feel as if the tube is going on; going in and getting stuck inside. I couldn't sleep troubled by that fear. (Interview 09, Patient I).

Moreover, fear of sleep is highlighted as the most discomforting factors not only in Sri Lanka but also in Iran (Arabi & Tavakol, 2009). It might be due to fear that patients do not to give sufficient information about their conditions by health care workers.

It can be summarized that intrapersonal experiences related to mechanical ventilation reveal feelings of pain, dependency, fear and anxiety, thirst, environmental discomfort and fear of sleep.

Extra personal experiences

The study revealed extra personal experiences related to mechanical ventilation such as feelings of congested secretions, experiences of suctioning, inspiration by Ambo and chest physiotherapy and had both positive and negative perspectives.

Feelings of congested secretions and experiences of suctioning were painful and irritating as reported in the Netherlands (Tosun et al., 2009). Moreover, the participants had both positive and negative experiences about the inspiration by Ambo and chest physiotherapy the same as in Iran (Arabi & Tavakol, 2009).

The tube is painful. I felt, I had committed grave sins. I was almost dying. I thought, it was better to die. When phlegm was removed, I felt a piece was going in. I questioned the existence of God. If they gave me air, it was ok. I felt like throwing the tube away. (Interview 09; participant I).

Phlegm was coming out. Chest physiotherapy was ok. (Interview 06; participant F).

Interpersonal Experiences

Communication difficulties and difficulty in expressing feelings are the most common interpersonal experiences that ensue among the ventilated patients. The inability to speak with the inserted endo-tracheal tube causes the patients to communicate with others by using hands and gestures. When these communicative expressions were not understood by the care providers and the paralyzed extremities gives them false interpretations, it was identified that these situations are moderate to extremely stressful events for the patients.

By hitting on the bar of the bed, I tried to communicate, I couldn't talk. (Interview 01, Patient A).

I couldn't communicate; I just enjoyed looking at the faces of my loved ones. (Interview 04, Patient D).

This experience of the inability to speak and not being understood is stressful or difficult same as in Portugal (Granja et al., 2005). It might have happened due to the health care workers being sometimes too busy to spend sufficient time to understand patients' modes of communication (Patak, et al., 2004).

CONCLUSIONS/RECOMMENDATIONS

The findings of this study determine the experiences of patients on mechanical ventilation in ICUs and shown that they were associated with the negative experiences of the participants. Pain, dependency, fear and anxiety, thirst, environmental discomfort and fear of sleep were described as uncomfortable and stressful intrapersonal experiences while difficulties in coping with suctioning and collecting of secretions, inspiration by Ambo, and chest physiotherapy are discomforts connected to extra personal experiences. Participants also indicated distress in attempting to communicate their needs during mechanical ventilation. This information offers insight into the need to minimize patients' unpleasant experiences by advancing knowledge and practices of health care providers in delivering ventilator assisted care for patients. A greater emphasis needs to be placed on the development of communication skills and advanced methods for mechanically ventilated patients by developing appropriate communication devices such as word or picture charts and alphabet boards. A formulated guideline needs to be integrated into the in-service programs, which will assist nurses to be more sensitive to the needs of patients on mechanical ventilators. It is important to develop a pain management team or unit in ICUs as well. These important areas of mechanically ventilated patient care especially from the nurses' perspective need further research. A comparative study regarding differences in the experiences of patients requiring long-term versus short-term mechanical ventilator is also suggested.

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PARENTS' KNOWLEDGE, ATTITUDES AND PRACTICES REGARDING RECURRENT ASTHMA ATTACKS IN THEIR CHILDREN

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INTRODUCTION

Asthma is a leading cause of chronic illness in childhood. It is a major public health problem and one of the most common prevalent chronic airway diseases amongst children (Bhider, Dhanjal & Shahid, 2007). Frequent hospital admission of children with asthma exacerbations is a common problem in pediatric care. Asthma is a common, chronic inflammatory condition of lung airways with three main characteristics as airflow limitation, airway hyper-responsiveness and inflammation of the bronchi (Clark & Kumar, 2002). The disease is caused by a number of factors such as genetics, infections, allergies, environmental irritant like cigarette smoke, exercise, emotional events and chemicals (Robertson & Robinson, 1998). Childhood asthma directly and indirectly leads to many complications including growth failure, chest deformities, restricted physical activity, recurrent hospitalizations and school absenteeism (Bandaranayake & Wijesooriya, 2010) and also it pose sudden danger to the child (Chen *et al.*, 2004).

Prevalence rate of childhood asthma in Sri Lanka is between 15 – 20% and reaching figures are higher as 35 – 40% in some areas (Ministry of Health, 2007). Because of the childhood asthma has many modes of presentation, precipitating factors, a number of triggering factors and variable response to the medications, the asthma cannot be managed without educating the parents and possibly modifying the environment (Ministry of Health, 2007). Parents of the sick children have significant role in prevention of recurrent asthma attacks of their children. There is no reported evidence regarding the parents' knowledge, attitudes and practices of preventing recurrent asthma attacks in children in Sri Lanka. The main purpose of this descriptive study is to describe the existing knowledge, attitudes and practices of parents about prevention of recurrent asthma attacks in children.

METHODOLOGY

A descriptive cross sectional survey was carried out at the Colombo South Teaching Hospital (CSTH) among 100 parents who have children with diagnosed childhood asthma. The sample was selected conveniently from the outpatient department (OPD), the pediatric asthma clinic and two pediatric wards. Data collection was carried out after obtaining the informed written consent of the participants and data were collected using self developed pretested self administered questionnaire. Ethical approval was obtained from the ethical review board of Colombo South Teaching Hospital. Data were analyzed using Microsoft Office Excel 2007-Version. Knowledge attitudes and practices presented as percentages.

RESULTS AND DISCUSSION

The response rate was 86% (n=86) and majority of the respondents (80%) were mothers and they were in the middle age group 30-39 years (57%). Majority of the participants (88%) was Sinhalese and Buddhist and nearly half of them (51%) had educated only up to ordinary levels. High percentage (67%) in the study group was unemployed and considerable

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proportion (41%) of the subjects were living closure to a main road and few of them(16%) were living closer to construction work site or a granite quarry where triggering factors for are common.

Table 1: Demographic data

variable	category	frequency	percentage
Age	21>30	7	8
	31>40	49	57
	41>50	25	29
	<50	4	5
Level of education	No schooling	2	2
	Up to O/L	44	51
	Pass O/L	13	15
	Pass A/L	23	27
	graduated	4	5
Employment	Unemployed	58	67
	Laborer	5	6
	Skilled laborer	2	2
	Semiprofessionals	9	10
	Professionals	3	4
	Self employment	5	6

In terms of knowledge on asthma and prevention of recurrence, majority (70%) knew that asthma is not a contagious disease and only (37%) knew that asthma is a hereditary disease. A high percentage of the participants (69%) believed that prevailing weather condition caused the recurrence of asthma and a high proportion of the participants (n=77) believed that domestic pets cause recurrence of asthma attacks. most of the parents (66%) knew, how to identify the asthma attack, when whistling sound was heard and only half of the parents (n=51) knew, how to identify the recurrent attacks, when child is coughing repetitively.

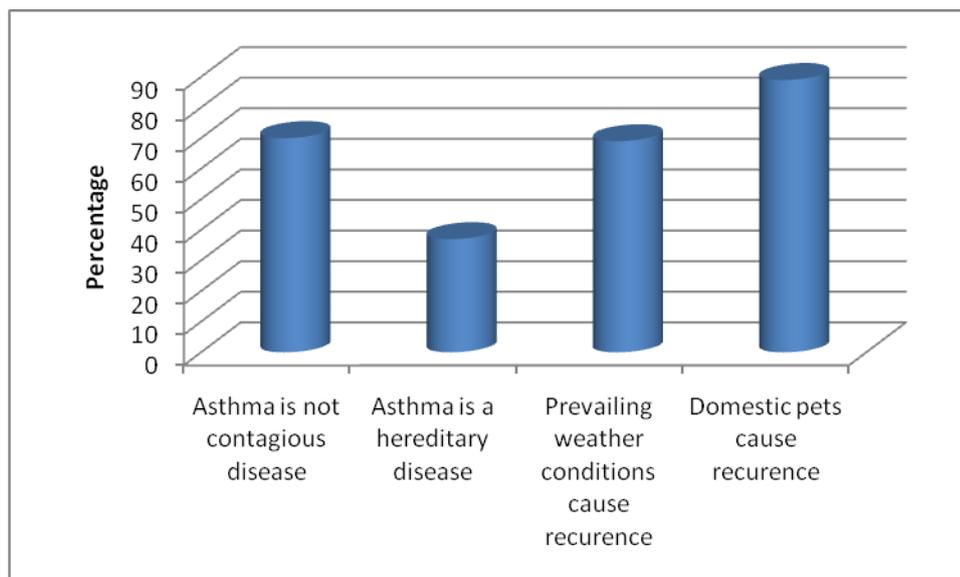


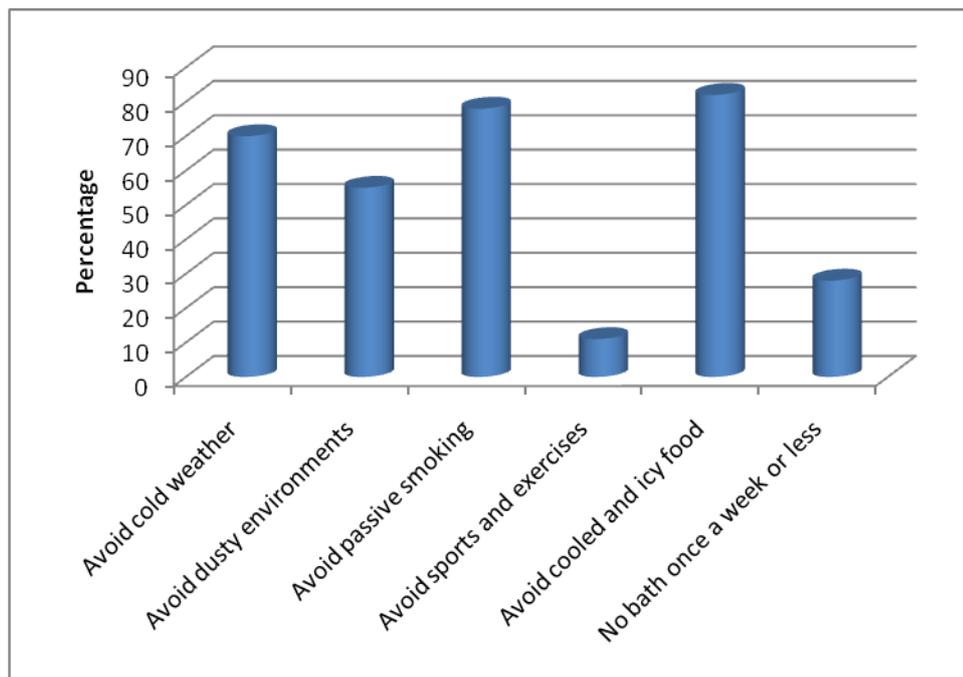
Figure 1: Knowledge about the disease

With respect to the pharmacotherapy, some parents (37%) did not know when to stop medication and nearly a half of the parents (49%) knew the continuation of medicine even without symptoms. Some of them (21%) said seriously they have no idea about drug therapy.

Table 2: Knowledge on pharmacotherapy

Statement	Frequency	Percentage
Did not know when to stop medicine	32	37
Continue medicine after cough was over	42	49
Stop all the medicine except inhalers when cough was over	32	37
No idea about drug therapy	18	21

Attitudes of the participants revealed that majority (78%) agreed that childhood asthma can be cured and avoid passive smoking from their children to prevent recurrent attacks. Large proportion (81%) had positive attitudes towards government hospitals rather than private hospitals. In addition, 40% of respondents had attitudes that prolong use of medication for asthma cause addiction.

**Figure1: Life style modification**

With regards to practices of parents to prevent recurrent asthma attacks, parents use different practices in different contexts. For an example, one study found that, 96% of children had restricted life style despite optimal control of symptoms with advanced drug therapies (Bandaranayke & Wijesooriya, 2010). In our study group, (70%) of parents avoid children from cold weather and (55%) avoid children from dusty environment. A Larger proportion (65%) use dump dusting in the house and (78%) avoid children from exposing to passive smoking. In addition, parents have chosen lifestyle modifications such as restrict exercises and sports (11%), restrict certain food items (cold, icy food), avoid daily baths so on. One author has suggested that the practices of life style restriction may be mainly due to myths and beliefs that prevailing in the society than symptoms of the disease itself (Fernando *et al*, 2009). Majority of our participants (62%) had at least three or more lifestyle modifications. However, some of them had harmful practices such as continuing the medications given from the previous visits to the doctor for same child or another sibling, having no idea about expiry dates and risk involved. In contrast one Indian study revealed that parents of the asthmatic children were more prone to give prophylactic drugs (*beta agonist / steroids*) prior to reach

the hospital but they take care to reach a hospital without delay (Anandanthen, *et al* 2005).

CONCLUSIONS

Study population had considerably high knowledge on some areas related to prevention of asthma attacks such as nature of the disease and risk factors for recurrence. Their knowledge was poor in early signs of asthma attack and pharmacological management of asthma. Attitudes towards the drug therapy and follow up care were also not favorable to prevention of recurrent attacks. Parents tend to impose number of life style restriction on their children and very often rely on prevailing misconceptions. There is a need to educate parents regarding correct home care practices while giving more emphasis on drug therapy in order to prevent recurrent asthma attack among the children.

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MEMORY IMPROVING PRACTICES: STUDENT NURSES' EXPERIENCES

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INTRODUCTION

Memory is a wonderful trait of human beings (Adams, 2001). It includes encoding, retention, the recall of past experience, knowledge, ideas, sensations and thoughts (Oxford Dictionary, 2000). Memory plays a major role in the learning process as it is the only evidence that something has been learnt. Students need better memory throughout their learning to perform. When applied to nursing education, nursing students belong to a specific group of learners who use their memory to acquire competencies in both the theory and practical components. Student nurses need better memory to become competent professionals to deliver standard nursing care. According to Adams (2001), memory can be improved by using various strategies.

As there have been no studies done on the memory improving practices of student nurses in Sri Lanka, it is important to identify the common practices they use, and their awareness of memory improving strategies. This study was carried out with the specific objectives of examining the knowledge and attitudes about memory-improving practices, the currently used memory-improving practices by student nurses and the perceived barriers among student nurses to improve their memory. It is important to develop an appropriate use of memory-improving practices and to overcome existing barriers among nursing students in improving memory to enhance the level of knowledge and skills of students. Hence, the findings of this study can be used to take necessary measures to increase awareness about memory-improving practices and to minimize memory failures of nursing students.

METHODOLOGY

A quantitative descriptive study was conducted at the School of Nursing, Anuradhapura in December 2013, to examine the practices of memory improvement among student nurses. A convenience sample of 200 nursing students, who were in their third academic year, was selected as they were preparing for their final examinations. A pre-tested, self-administered questionnaire was used to collect data. The questionnaire consisted of three parts, which were focused on demographic data, on knowledge and attitudes of memory-improving strategies and on memory-improving currently used practices and the perceived barriers related to those practices.

Ethical clearance was granted from the Ethical Review Committee of the Faculty of Medicine, University of Rajarata, Sri Lanka. Permission was taken from the principal of the School and informed consent was taken from each student before conducting the study. Collected data was analyzed by using descriptive statistical methods (Microsoft Excel).

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RESULTS AND DISCUSSION

A total of 190 students participated in the study, with a response rate 95%, of whom 94.7% were female and 5.3% were male.

Out of the total participants, 118 (62.1%) agreed with the statement that memory can be improved by using various strategies. Regarding knowledge of memory-improving strategies, the study found that a majority of participants was knowledgeable about common memory improving strategies. From among these strategies, the discussion of study subject matters with others (97%) and rehearsals (96%) were the most known strategies for memory improvement (Figure 1).

There is a significant difference between knowledge and the current practices of memory-improving strategies. Though the majority of participants knew almost all the memory-improving strategies, less than 50% of the participants applied them in practice. The biggest deference between knowledge and practice was observed in the ‘discussion of subject matters with others’ (Deference: 84%) strategy, while the ‘Learning more information based on subjects’ was the strategy that was used by the least number of participants (1%). The reasons this may be a lack of time because clinical placements and study leave are not granted. Nursing, as a practical subject that requires “putting knowledge into practice”, is an important strategy to improve memory. However, it was practiced by only 11% of the participants.

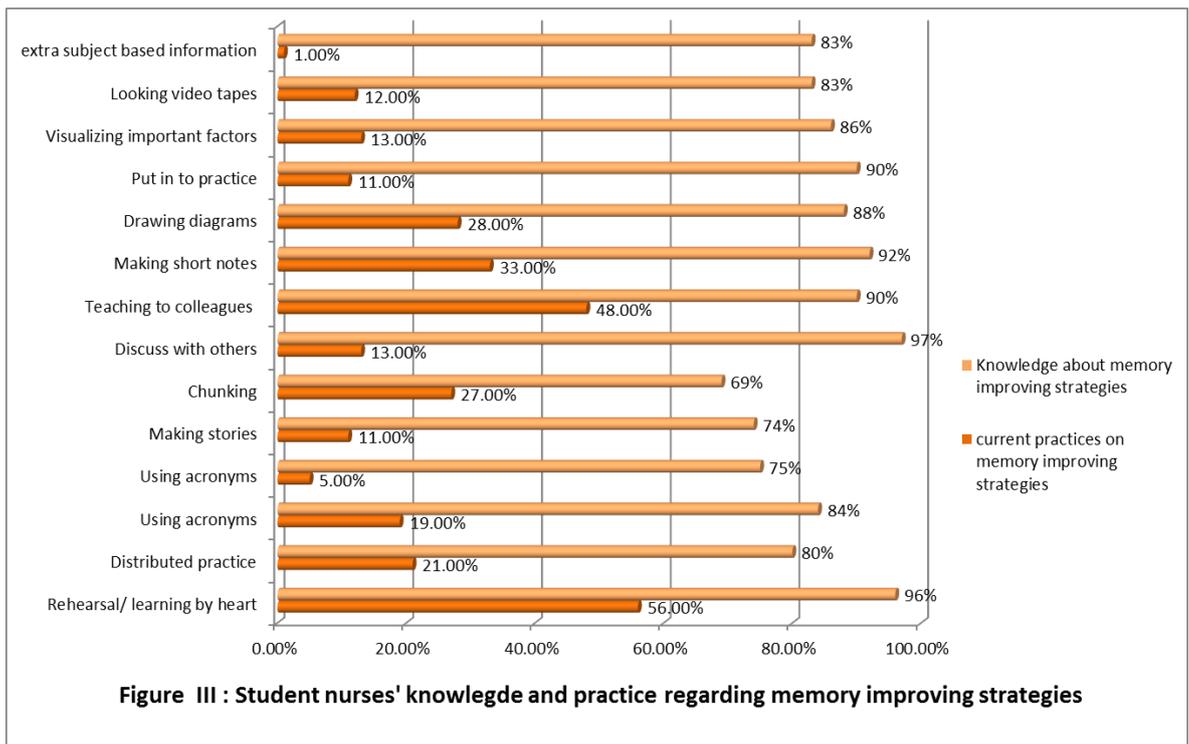


Figure 1: Student nurses’ knowledge and practice regarding memory improving strategies

Participants identified several barriers to improving memory during their study periods. Using long study periods was the major barrier they reported (87%). Other barriers included poor qualities of teachers, a lack of motivation, unfavorable physical environments, stresses of clinical hours, unsatisfactory teaching methods, congested curriculums and problems experienced in residences. Nilsson (2008) highlights that there is a significant relation between the degree of motivation and learning by student nurses. In this study, 61% of students reported internal factors, such as self motivation and motivation by others, affected

their memory. A lack of physical facilities (56%) and problems at residences (21%) were the other existing perceived barriers to their memory improvement. A study by Johansen (2012) reveals that responsibilities at home affects student learning. Of the sample, 51% stated that stresses of clinical experiences were perceived as a barrier for their learning. Whereas in the study by Miek (2011), it is reported that most nursing students experienced stress and anxiety during their clinical experiences and they have found it difficult to cope.

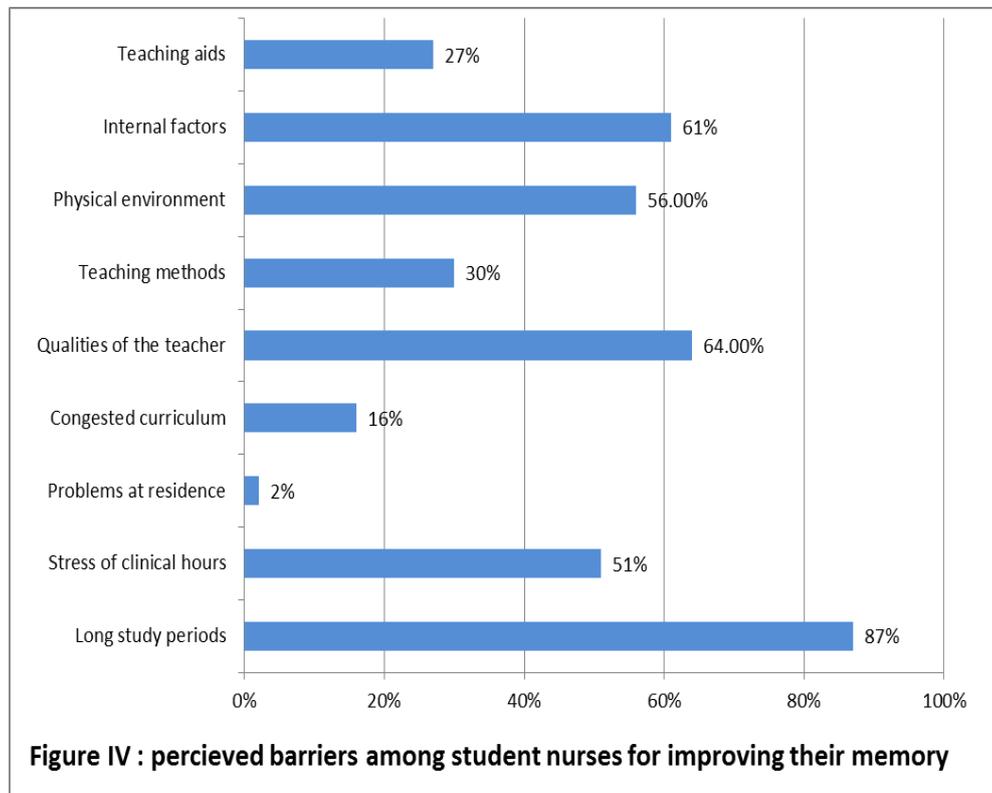


Figure 2: Perceived barriers among student nurses for improving their memory

CONCLUSION

This study examined student nurses' knowledge and practices about the memory-improvement practices of student nurses at the School of Nursing, Anuradhapura. The results showed that most student nurses were aware about almost all the common memory-improving strategies, but were not practicing them appropriately. Further, they perceived various barriers to their memory-improvement. Therefore, the success of memory-improvement could not be achieved well.

Therefore, the study suggests that educators involved in nursing education play a significant role in facilitating the memory improvement of student nurses. Furthermore, the organization of programmes need to be developed in co-operation with students to match content in courses and the students' different degrees of motivation during their academic years, and curriculum revisions should be done regularly. Further, student-oriented learning methods should be emphasized on more thoroughly than classroom instructional methods, and students should be exposed to active learning activities throughout the nursing curriculum in order to develop familiarity with different learning strategies. Curricula should be tested as to whether content is adequate to cover all necessary information resulting in students being made free from extremely heavy workloads. Therefore, administrators in nursing education need to consider the focus of the curricula and their impact on the student learning process and outcomes.

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EXPERIENCE OF TEENAGE PREGNANT MOTHERS: BY CHOICE OR BY CHANCE

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INTRODUCTION

Pregnancy is a challenging time for all women as they adjust to the changes they experience and prepare to assume a new role as a mother. This may be a factor in a woman's adjustment both physically and psychologically (Ladewing *et al.*, 1996, p.395). Among the developmental stages of a human, the adolescent period is stressful in general due to the making of rapid physical growth, and cognitive, emotional and social change for both girls and boys. In particular, when girls become pregnant during their teenage period, the situation introduces additional stress to them. Teenage pregnancy refers to pregnancy in a female under the age of 20 (when the pregnancy ends) (Treffers, 2003). For most teenage girls, pregnancy is an unplanned, unwanted event that adds to the complexity and difficulty of the teen years which requires more adjustment, both physically and mentally (Scolveno *et al.*, 1995). Furthermore, those who become pregnant during teenage years face a higher risk of complications and death as a result of pregnancy than older women (Myclutyne, 2007). Therefore teenage pregnancy is a worldwide phenomenon which represents the most critical problems. In Sri Lanka the overall percentage of teenage pregnancies remained more or less stable and stayed between six to eight percent during the last four years and it varies among Regional Director of Health Services (RDHS) areas.

Early marriages, premarital sex, lack of knowledge of contraceptives, violence and coercive sexual intercourse lead to pregnancy by choice or by chance among teenagers. Hence, this study was carried out with the objectives: to discuss the marital background of teenage mothers, assess knowledge and attitudes regarding safe motherhood and pregnancy among teenage mothers, and physical difficulties experienced by teenage mothers during pregnancy and the strategies they used to overcome them. The psychosocial relationships teenage mothers had with their husbands and family members were also discussed.

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METHODOLOGY

The study was conducted at the obstetrics wards of the De Soysa Hospital for Women (DSHW) in Sri Lanka. A qualitative approach was used to explore the experiences of teenage pregnant mothers and a phenomenological approach was used. The target population were teenage pregnant mothers (age 13 to 19) who had had a fetus or neonate for 28 weeks or more during the period of 27th January to 15th February 2013. The purposive sampling method was used and the sample size was fifteen. Ethical approval was granted by the ethical board of DSHW. In-depth interviews were conducted to collect data. The potential questions formulated were used throughout the interviews for further exploration of areas related to the objectives. Interviews were tape recorded and the privacy of the mothers' was strictly protected. All recorded interviews were transcribed manually word by word. Multi-steps content analysis was used to analysis the data. Transcribed data was coded and themes were generated according to the objectives of the study.

RESULTS AND DISCUSSION

Early marriages for economical independence for the parents, sex and love in relationships, frightening experiences, knowledge deficit of pregnancy and contraceptives , unhappy childhood, family oppression and family support emerged as themes in relation to the objectives of the study. The study reflected that most teenage mothers got pregnant at the age of 17. These findings were similar to the findings of the study in Sub Saharan Africa (Treffer, 2003) which had the highest rates of teenage pregnancies in the world.

In relation to the theme early marriages for economical independence for the parents derived from the study as a reason for the teenage pregnancy, there were some incidents of arranged marriages by parents as both an economically and socially protective arrangement for their teenage daughters and the family. Although there are many legal barriers, some parents tend to organize early marriages for their daughters as such practices are permissible in the socio cultural systems in Sri Lanka.

"I am married ... my parents wanted me to get married... I wanted to continue my studies.. I was not prepared to marry him.. I did not know him. ..but my father forced me ... he promised to help my father to start a business...I got pregnant immediately after marriage.. I am still not ready to bear a child" (married, 17 years)

According to the theme sex and love in relationship derived from the study, there were a few incidents of casual relationships and unprotected sex.

"My boyfriend met me at my home because my parents know him... I was alone at home ... we felt in love I did not know what happened to me...It was happened several times...I did not refuse it" (living together, 17 years)

Furthermore, Paelate&Saskiao (2005) found that coerced sex and forced sex were also most common reasons for the teenage pregnancies in Thuvalu. In contrast, the study in United States of America found that only a small percentage of adolescents were married and that the most common reason for teenage pregnancies was casual and unprotected sex relationships with boyfriends and peers (Singh & Darroch, 2000). The reason might be the cultural and life style differences.

According to the theme knowledge deficit of pregnancy and contraceptives derived from the study, the majority of teenage mothers had some understanding of the reproductive system and menarche. However they had poor knowledge about pregnancy, safe motherhood and contraceptives. Most of teenage mothers were found to be unaware of emergency

contraceptive measures. Failure to use contraceptives was the most common reason to become pregnant in teen years. The same findings were also reported in other studies (Ehlers, 2003; Paelate & Saskio, 2005; Weggins et al., 2005).

“I got married at 16... I got pregnant....I did not know about family planning andpregnancy. It was something I found very hard and difficult....if I had known about it definitely I would have used it...I feel.. I am still not ready to look after a baby ..” (married, 16 years).

According to the theme frightening experiences, the study also reflected that most unmarried teenagers immediately felt fear, shame, anxiety, guilty, disappointment and helplessness when they found out they were pregnant.

“I wasn’t sad or happy...I was in shock and was very scared about what might happen at home.. I remembered my parents.. I felt shame and helplessness” (unmarried, 17 years)

In addition, the study found that married teenagers also felt fear and anxiety, but on the other hand they felt happy and a sense of fulfillment in life. The unexpected pregnancy created confusion regarding feelings and desires of the pregnancy. It might be the degree of social acceptance of pregnancy and motherhood which was the major difference between married and unmarried adolescents in Sri Lanka.

According to the theme positive experiences derived from the study, while most teenage mothers perceived their pregnancies in positive way, a few teenagers were concerned about an abortion. After the initial shock, the pregnancy was accepted over time by the majority of young women and the baby was eagerly anticipated (Mcdermott et al., 2004).

“It (the pregnancy) has made me more complete ...I have a goal now and I have something to achieve and I have him to bring up in the best way.. I can and give him the best of everythingmy boyfriend wanted me to get married...” (living together, 18years)

In contrast, the study of South Africa Rotchir & Mlambo (2005) found that most young teenage mothers were not happy about their pregnancies and performed illegal abortions because it might be a crisis for themselves and their families.

According to the theme unhappy childhood derived from the study, the majority of teenage mothers belonged to the families that have a lack of parental supervision, protection and with lower income. Whilst some of them had fair relationships with their families, most teenagers experienced home violence. The studies Jaccord et al. (2003); Weggins et al. (2005); Barn & Montawani (2007) also reported similar findings.

“During childhood.. I stayed away from the family...my mother was a middle-east worker for many years.. Father kept me at his sister’s house.. I lost love..I wanted to be free from the stagnant life and to find love and care.” (living together, 16 years)

The theme family oppression which was derived from the study, the majority of teenagers’ mothers were more sympathetic toward their daughters, while most fathers were very disapproving and openly showed anger and disappointment through both words and actions. The anger of parents makes such teenagers hide their pregnancy from their family and society.

“ My father was very furious...he assaulted me a lot.. and chased me ...he did not speak with me for a long time.. Then I decided to leave my parents and go with my boyfriend” (living together, 17 years)

“I was very scared, I did not reveal it to my mom till another five months passed. I was very close to my elder sister who I told everything to and she had told everything to mom. My mother was very angry and she persistently refused me until my baby was born.”(living together, 16 years).

According to the theme family support, most teenagers perceived that family support plays a significant role in minimizing the distress that they experienced during pregnancy. The study found out that over time most parents became more accepting and looked forward to the birth of their grandchild. Family support seemed most valuable when it helped women develop their own skills as mothers. Some grandmothers played an important role in taking over the complete care of their grandchild.

“Without the help of my mother I don’t think I would have been able to cope..my mother look after me ..now she has to look after my baby also”(living together, 17 years)

The recent studies by Mcdermott et al (2004); Weggins et al (2005) also found out that kin relationships offered emotional, financial and practical support for teenage mothers.

CONCLUSIONS/RECOMMENDATIONS

The study reflected two major reasons for early motherhood in teenagers. They are early marriages through love affairs or family arrangements and casual relationships with boyfriends. Furthermore, lack of knowledge about contraceptives also lead to unexpected teenage pregnancies.

Parents and relatives should be educated to discourage facilitating early arranged marriages for their daughters and it should be emphasized that parents (specially mothers) must be the main source of sexuality and relationship education. The communication gap between parents and teenagers should be reduced by changing attitudes.

Establishing and strengthening adolescent friendly health services and the training of health care workers must be promoted to meet the needs of their young clients by changing attitudes. Age appropriate formal sexuality educational programs should be often arranged in schools and adolescent clinics for school leavers. Sexuality education must cover not only the biological aspects of the reproductive system and reproductive issues but also communication, pleasure, self-esteem and negotiation. In addition, teenagers must receive sex education before menarche and it should be taught by specially trained health care professionals or experts. Pregnancy, motherhood and contraceptives including emergency contraception and accessible services should also be discussed.

Young teenagers should be empowered with information and decision making life skills on how to protect themselves from forced sex and accidental pregnancies. Boys must be educated about gender issues and respect for women as well as their needs. Further quantitative and qualitative research studies need to be conducted to gain a more inclusive understanding of teenage pregnancies

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USE OF A PCR ASSAY TO DETECT DIROFILARIOSIS IN DOGS AND DEVELOPMENT OF A LABORATORY METHOD FOR VECTOR IDENTIFICATION

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INTRODUCTION

Dirofilaria are a group of mosquito borne filarial nematodes. They infect dogs and other carnivores. The widely recognized parasites among them are *Dirofilaria immitis*, the agent of cardiovascular dirofilariasis and *Dirofilaria repens* causing sub cutaneous infections (Soner *et al.*, 2002). Humans may become infected as aberrant host but the worms fail to reach adulthood while residing in a human body (Pampiglione, 2001). As with other filarial species, mosquitoes transmit infectious microfilaria. *Dirofilaria repens* infections have been reported from various regions of the world, mainly from Eastern Europe, Sub Saharan Africa and Asia. Human dirofilariosis due to *Dirofilaria repens* is a common zoonotic infection in Sri Lanka. This study was aimed to evaluate the role of *Armigerus subalbatus* as a vector for *Dirofilaria repens*, hence a laboratory method was established to identify the vector mosquito for *Dirofilaria repens*.

METHODOLOGY

Experimental mosquitoes

A strain of *Armigerus subalbatus* mosquitoes were used in this study. These mosquitoes were originally provided by the Department of Pathobiology in the Faculty of Veterinary Medicine and Animal Sciences, University of Peradeniya. The female mosquitoes were fed with blood to stimulate egg laying. The mosquito colony was maintained on 5% sucrose solution at room temperature.

Collection of infected blood samples

Dirofilaria repens infected blood samples were collected from dogs admitted to the Animal clinic at the Government and private Veterinary Clinics, in the Kandy area. Numbers of microfilariae in wet smear were counted. The stained slides were used to identify the microfilariae.

Feeding of Mosquitoes with infected blood

An artificial membrane feeding apparatus was designed to determine the ability of this mosquito to transmit the disease under laboratory conditions. To verify the transmission of infection, randomly selected 2-3 fed mosquitoes were dissected immediately after feeding and looked for microfilariae in the gut. These examinations were continued at time intervals to monitor the development of the parasite. Until the end of experiment the mosquitoes were fed with 5% sucrose solution.

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DNA extraction and PCR analysis

DNA was extracted from microscopically diagnosed *Dirofilaria repens* infected dog blood, and the mosquitoes were fed with infected blood through the artificial membrane feeding apparatus. Amplification of 12Sr DNA (DNA of the small subunit of ribosome) was done using a *Dirofilaria repens* species specific primer pair 12SF- 5' GTT CCA GAA TAA TCG GCT A- 3' and 12SR2- 5' AAA AGC AAC ACA AAT AA(CA)A 3'. LSU5- 5' ACC CGC TGA AYT TAA GCA 3' forward and LSU3 – 5' TCC TGA GGG AAA CTT CGG 3' reverse primers were used to analyze the DNA of the large subunit of ribosome of nematodes including that of microfilaria. Finally, Amplification products were visualized on 0.8% agarose gel stained with Ethidium Bromide.

RESULTS

Determination of microfilarial density

A total 10 blood samples were collected for this study. Each blood sample was examined by light microscope under 40X magnification. All 10 blood samples were identified as having *Dirofilaria* infection. The maximum count of microfilariae per 20µl of infected blood was 215, while lowest count was 28.

Morphology of microfilaria

Microfilariae of *Dirofilaria repens* had characteristic gently curved bodies. They were unshathed and the tail was tapered to a point. The nuclear column was tightly packed and the nuclei were not visible individually.

PCR analysis of infected blood samples with 12SF and 12SR2 primer pair

Amplification of all DNA templates with 12SF and 12SR2 specific primer pairs produced the expected 327bp long PCR product (figure 1).

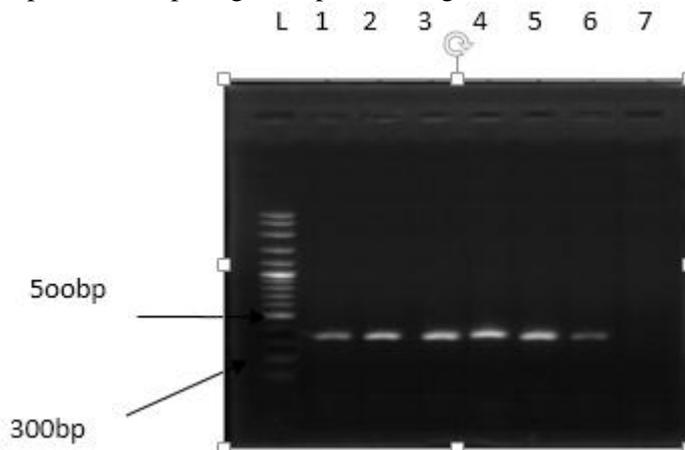


Figure1: The amplicon is 327bp for *Dirofilaria repens*. L: 100 bp DNA molecular marker; lanes 1 -5: the infected blood samples; lane 6: positive control; lane 7: negative control.

Transmission of the disease under laboratory condition

The artificial mosquito membrane feeder successfully transmitted the disease under laboratory conditions. It was proven by the observation of microfilariae in the abdomen of mosquitoes immediately after feeding and then the other developmental stages.

PCR analysis of experimentally fed mosquitoes with LSU5 and LSU3 primer pair

The DNA of the large subunit of ribosome of nematodes including *Dirofilaria repens* was amplified by using LSU5 and LSU3 primers. The expected 1100bp PCR product was obtained (figure 2). However positive DNA bands could not be obtained when the DNA was amplified by *Dirofilaria repens* specific primer pair.

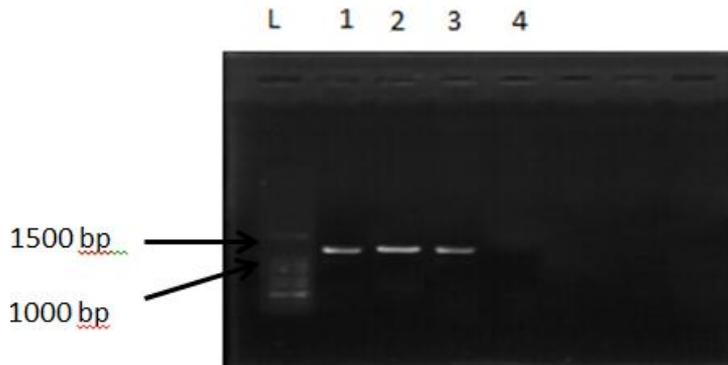


Figure 2: The amplicon is 1100bp L: 1kb DNA molecular marker; lane 1: first stage larvae presented specimen; lane 2: second stage larvae presented specimen; lane 3: positive control; lane 4: negative control

PCR analysis of wild caught mosquitoes with LSU5 and LSU3 primer pair.

Expected 1100bp long PCR product was obtained from some wild mosquitoes (figure3)

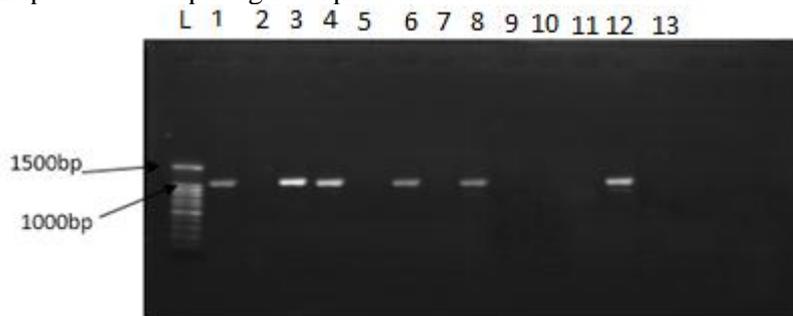


Figure 3. The amplicon is 1100bp size. L: 1kb DNA molecular marker; lane 1: pool of *Aedes* from Kandy; lane 2- 4: Pool of *Armigerus*; lane 5: pool of *Culex* from Kandy; lane 6-8: pool of *Culex* from Anuradhapura; lane 9: pool of *Armigerus* from Anuradhapura; lane 10: pool of *Aedes* from Anuradhapura; lane 11: pool of *Mansonia* from Anuradhapura; lane 12: positive control; lane 13: negative control

DISCUSSION

The *Dirofilaria repens* species specific primer 12SF (5'-GTT CCA GAA TAA TCG GCT A-3') and 12SR2 (5' AAA AGC AAC ACA AAT AA (CA) A -3') used in this study amplified the expected 327bp long *Dirofilaria repens* specific DNA product. All DNA templates extracted from whole blood were successfully amplified with *Dirofilaria repens* species specific primers and showed the expected 327bp long PCR product. These results were indirectly confirmed by amplification of the DNA of the large subunit of ribosome in nematode including that of *Dirofilaria repens* microfilaria with LSU 5 (5'- ACC CGC TGA AYT TAA GCA 3') and LSU 3 (5'- TCC TGA GGG AAA CTT CGG 3') primers. Therefore *Dirofilaria repens* specific PCR diagnostic method used in this study will be useful to diagnose Dirofilariosis due to *Dirofilaria repens* infection.

One of the aims of this study was to establish an *in vivo* model to identify the vector mosquitoes of the *Dirofilaria repens* infection. The *Armigerus subalbatus* mosquitoes used

for experimental infection in this study appeared to be a suitable host for the *Dirofilaria repens* nematode larvae development, since larvae entered the abdomen of mosquito and reached the “sausage stage” and thereafter the second stage larvae in this species. Therefore results suggest that *Armigerus subalbatus* can support *Dirofilaria repens* transmission under laboratory conditions. It might require more than 16 days to develop third stage larvae and might be a possible cause for the disappearance of third stage larvae during the end of the experiment.

Although *Dirofilaria* larval development in *Armigerus subalbatus* mosquitoes maintained under laboratory conditions was proved by the mosquito dissection and PCR analysis using LSU primers, positive bands were not amplified with 12SF and 12SR 2 primers. The 12SF and 12SR 2 primers may be less sensitive when compared with the LSU primers and this may be the reason for getting positive bands when DNA was extracted from infected dog blood and not getting positive bands when DNA was extracted from infected mosquitoes.

Blood feeding is one of the problematic activities in culturing mosquitoes. Even when ethical rules permit the use of a live animal, their care and housing are expensive and time consuming. Due to restriction and difficulty in using live animals in a research setting, artificial membrane feeding methods have been developed. Successful transmission of infection was observed in this study and it was proven by the presence of microfilariae in the abdomen immediately after feeding. Therefore this apparatus can be easily used to transmit infectious microfilaria and identify any of the vector mosquitoes of microfilaria. The *Dirofilaria repens* specific PCR diagnostic method that has been applied in this study is useful to detect the blood parasite. Identification of the vector mosquito for *Dirofilaria repens* is important in order to decrease the risk of infection to other dogs and humans in the vicinity of the infected animals when mosquito vectors are present.

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IMPACT OF CULTURAL DIVERSITY ON NUTRITIONAL STATUS OF PREGNANT MOTHERS AND ANTHROPOMETRIC MEASUREMENTS OF THEIR BABIES

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INTRODUCTION

All people in the world belong to some kind of cultural group (Taylor, 1986) and cultural diversity influences the way the people look at the world. Therefore differences in thoughts, beliefs and attitudes can be seen among different cultural groups. Thus, variations in food practices among different cultural groups will occur due to differences in their beliefs and attitudes (Rodriguez, 2013). Infancy, childhood, adolescence and pregnancy are the special periods in which the correct nutrition is vital (Timothy & Sthapit, 2004). Pregnant women are particularly vulnerable to changes in the nutritional status because of the metabolic changes during pregnancy. Furthermore, the nutritional status of pregnant mothers determines the growth of the foetus. Therefore, food habits of different cultures may affect the nutritional status of pregnant mothers and thereby the growth of their babies (Adetona *et al* 2013). Impairment of the nutritional status of pregnant mothers is a major public health problem. The impairment of nutrition during pregnancy can have adverse effects on the mothers such as anaemia, obesity, gestational diabetes mellitus and hypertension. In addition, consequences to the neonate from maternal nutritional imbalance are stillbirths, large babies, pre-term deliveries, intra uterine growth retardation and congenital malformations (Adetona *et al*. 2013). These consequences lead to changes in the babies' anthropometric measurements such as height, weight and head circumference. Therefore, it is imperative to examine how cultural diversity impact on mothers' nutritional status and thereby anthropometric measurements of their babies.

Thus, the purpose of this study is to examine the impact of cultural diversity on the nutritional status of pregnant mothers and the anthropometric measurements of their babies. The specific objectives are to examine the existing food practices among pregnant mothers belonging to various ethnic groups, to assess knowledge and attitudes of pregnant mothers who are from different cultures regarding nutrition and food habits, to identify the barriers among pregnant mothers for the desirable food practices and to find out the significances between the ethnic groups and the nutritional status of pregnant mothers and anthropometric measurements of babies.

METHODOLOGY

Quantitative approach and descriptive design was used in this study. The target population was pregnant mothers who completed 37 weeks of pregnancy and who belong to the cultural groups of Sinhala Buddhist, Sinhala Catholic, Muslim and Tamil. Fifty mothers from each cultural group were selected as the sample of the study. Therefore the sample size was two hundred. The sample was selected by using purposive sampling technique. Closed ended questionnaire was used as the tool to collect the data.

Content validity of the tool was assured by referring to the standard literature and subject experts. Reliability and understandability was assured by performing a pre-test.¹

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The study was conducted at the Castle Street Hospital for Women and at the Base Hospital, Puttalam. Ethical clearance was granted from the ethical review board of Castle Street Hospital for Women. Data was organized using Microsoft Excel and Minitab statistical software for statistical analysis of data.

RESULTS AND DISCUSSION

According to the findings of this study, only 4 % of Sinhala Catholics and 10 % of Tamil mothers were vegetarian while all the others in every cultural group were non vegetarians (Table 1). According to Dindyal (2003) some Hindus who are strictly religious attempt to be vegetarians. This relatively higher percentage of vegetarian mothers in Tamil culture might be due to the religious principle of non violence applied to animals in Hinduism (Tahtinen and Unto, 1976). Although, the same principle applies in Buddhism, the study shows that none of the Sinhala Buddhists were vegetarians. When considering the consumption of rice, most of the mothers of every cultural group (more than 50%) consume white rice and a lesser number of mothers in every cultural group consume red rice. According to the study, more than 50% of mothers in every ethnic group do not consume tea or coffee before or after two hours of a main meal. According to Dindyal (2003) although, the choices and selections of food that people make would vary with the culture and ethnicity these findings shows that there are no significant differences in existing food practices among mothers from different cultures in this study.

Table 1: Prevalence of vegetarianism

Ethnic group	Vegetarian	Non Vegetarian
Sinhala Buddhist		100%
Sinhala Catholic	4%	96%
Muslim		100%
Tamil	10%	90%

Table 2: Knowledge of mothers' regarding nutrition

Ethnic Group	Caffeine influences iron absorption		Vitamin C is necessary for iron absorption		Importance of supplementary vitamins	
	Know	Don't know	Know	Don't know	Know	Don't know
Sinhala Buddhist	68%	28%	80%	18%	100%	
Sinhala Catholic	72%	20%	88%	4%	90%	-
Muslim	74%	26%	86%	14%	94%	6%
Tamil	60%	40%	82%	18%	84%	16%

Although, the majority of rural women in India enter motherhood without adequate information about maternal health (Sharma and Sharma, 2012), this study found that pregnant women in Sri Lanka have adequate knowledge on maternal health. This is indicated by the study findings saying that more than 60% of mothers in every ethnic group knew that "caffeine influences iron absorption" and over 80% of mothers in every ethnic group knew

that “vitamin C is necessary for iron absorption” while all Sinhala Buddhists mothers knew the importance of supplementary vitamins (Table 2). Sometimes this higher level of knowledge of Sri Lankan pregnant women might be due to widespread maternal health educational programs in Sri Lanka. Furthermore, it shows that there is no considerable difference in knowledge regarding nutrition among mothers. According to the findings, economical problems are the most prominent barrier among mothers to follow health advice (Figure 1). Furthermore, the study reveals that cultural and traditional beliefs are significant barriers for Muslims to follow health advice.



Figure 1: Barriers to follow health advices

According to the study, 46 % of Muslim mothers’ Body Mass Index (BMI) level was beyond normal range (> 24.9) and was in the overweight range (Figure 2). But 62% of Sinhala Buddhists mothers’, 64% of Sinhala Catholic mothers’ and 64% of Tamil mothers’ BMI level was within the normal range (18.5- 24.9). This is in agreement with Webster (1998) who stated that according to his study the BMI of a majority of Muslim mothers was beyond 24.9. Furthermore the study shows that hemoglobin (Hb) level of mothers’ in every cultural group is in the reference range.

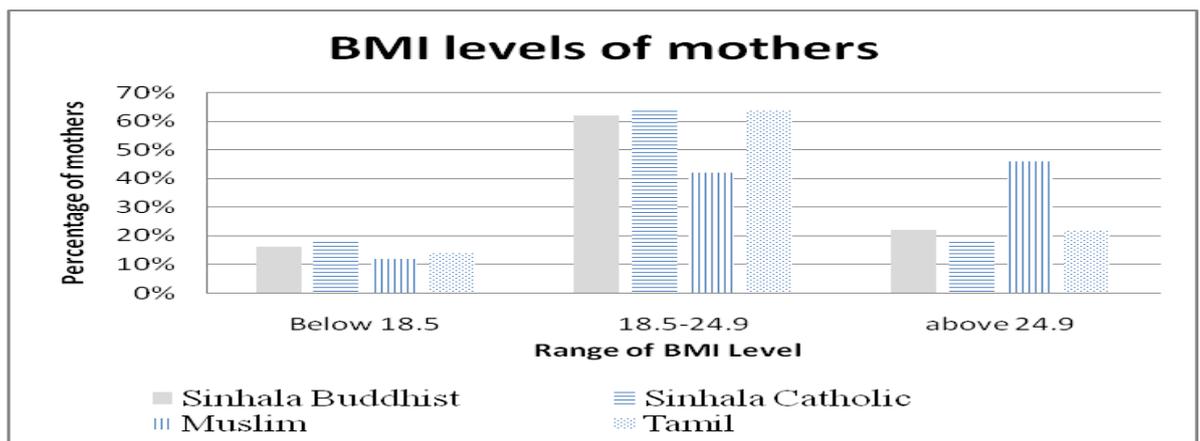
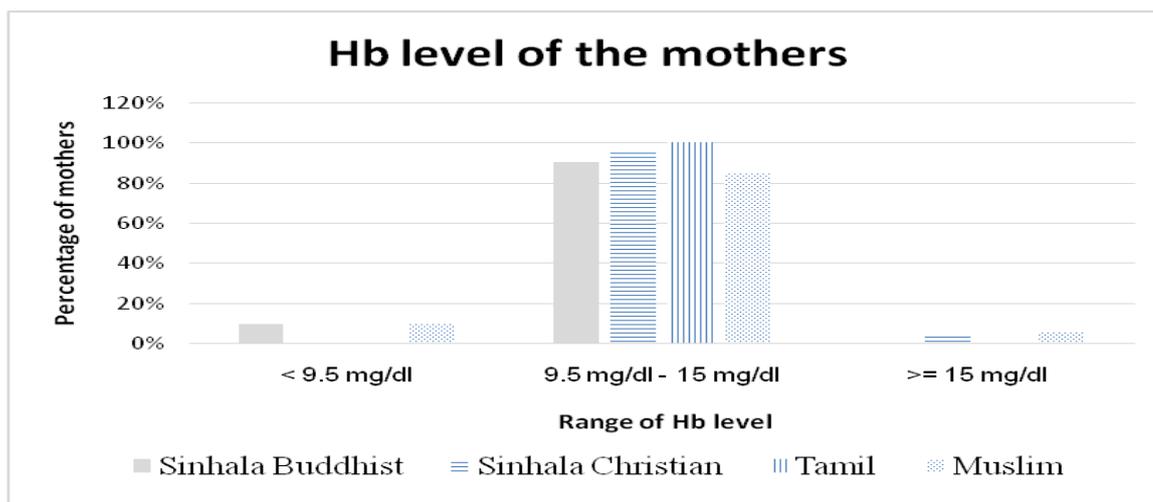


Figure 2: BMI level of mothers



Hb = Haemoglobin

Figure 3: Hb level of mothers

Sharma and Sharma (2012) stated that the health status of the new-born babies depend on the mother's knowledge, attitudes and practice of various health measures during the pregnancy. According to the study findings, more than 75% of babies' birth weight is in reference range. But 18% of Sinhala Buddhist babies are below 2.5 kilograms. The mean length of newborns in Sinhala Buddhist, Muslim and Tamil babies were around 51cm. But, mean length of Sinhala Catholic babies is around 54cm. Regarding the head circumference the mean head circumference of babies of all four cultural groups is around 32.5cm.

Table 3: Birth weight of babies

Ethnic group	Below 2.5kg	2.5kg - 3kg	3.0kg- 3.5kg	3.5kg-4kg	Above 4kg
Sinhala Buddhists	18%	50%	26%	6%	
Sinhala Catholic	4%	50%	40%	6%	
Muslim	4%	50%	26%	20%	
Tamil	8%	54%	20%	14%	4%

CONCLUSION / RECOMMENDATIONS

According to this study there is no significant association between the culture and vegetarianism ($p = 0.29$). Although there is no significant difference in knowledge regarding nutrition among pregnant mothers of different cultural groups, the extent of knowledge regarding nutrition varies. Furthermore, economical problem are a noteworthy barrier in following health advice among all cultural groups while cultural and traditional beliefs are barriers to some degree among the Muslims. However this study shows that there is a significant association between the culture and the BMI of mothers ($p = 0.017$) and BMI of mothers and the birth weight of babies ($p = 0.000$). Furthermore, it shows that there is no significant association between Hb level of pregnant mothers and birth weight of their babies ($p = 0.605$). Regarding the head circumference of babies there is no significant difference among the four cultural groups. Finally, the study findings help to conclude that there is no significant impact of cultural diversity on pregnant mothers' nutritional status except BMI and specifically for anthropometric measurements of their babies except birth weight. However these results should be further examined and should be done in several areas to generalize the findings.

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KNOWLEDGE, ATTITUDES & PRACTICES RELATED TO RABIES AMONG PATIENTS WITH ANIMAL BITES

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INTRODUCTION

Rabies is a viral disease which affects the central nervous system and occurs in wild and domestic mammals, particularly carnivores (flesh-eating animals; mainly dogs, bats, cats, monkeys and foxes). The rabies virus is contained in saliva and is transmitted to humans mainly through the bites of infected animals (Hashim, 2007). As the rabies virus affects the nervous system, there is no cure for rabies, after onset of signs (Bresalier & Worboys, 2014). Rabies in humans is highly fatal and ends in an extremely painful and tortuous death (Dissanayake *et al.*, 2007). It is also known as ‘Hydrophobia’ which means ‘fear of water’ (Mani & Madhusudana, 2008). A number of people and thousands of animals die due to rabies around the world (Campbell *et al.*, 1968).

More than 55,000 people die due to rabies in each year, mostly in Asia and Africa (Campbell *et al.*, 1968). In India, more than 96% of the cases of rabies were mainly through dog bites (Suraweera & Morris, 2012). In Sri Lanka, 377 rabies deaths were reported in 1973 that has reduced to 58 in 2009 (World Health Organization (WHO), 1998), 49 deaths in 2010, and 41 in 2011 have been reported (Kumarapeli & Friedlander, 2009). Despite the government spending a considerable amount of money and taking considerable steps to prevent incidents of rabies, reports reveal that it still continues to be an ongoing problem in Sri Lanka. According to the previous finding (Dissanayake *et al.*, 2007) priority should be given for the implementation of rabies control programmes in rural areas. It is assumed that lack of knowledge, attitudes and practices could be major reasons for its high incidence and control of human public awareness is crucial to prevent rabies in Sri Lanka (Tamashiro *et al.*, 2007). Therefore the purpose of this study was to examine the knowledge, attitudes and practices related to rabies among patients infected by animal bites who under treatment at the Base Hospital, Homagama.

METHODOLOGY

Quantitative descriptive design was used for the study to assess simple random sample of 120 animal bite victims, who are treated at the Base Hospital Homagama. A pre-tested questionnaire was used as a tool to assess Knowledge, Attitudes and Practices related to rabies among patients infected with animal bite. Content validity of the instrument was assured by referring to standard literature and subject experts. Ethical clearance was granted from the National Hospital of Sri Lanka. Voluntary participation was encouraged and written informed consent was obtained from each participant, prior to the study.

RESULTS AND DISCUSSION

Majority of the participants were females, 65% while males were 45%. Considering the educational attainment of the participants, 56.7% of them have studied up to Ordinary Level

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while 8.3% of the participants have studied up to Grade 5. Among the 120 participants, 30% have had educational attainment up to Advance Level while 5% of the individuals had achieved higher education. When considering the professional status of the participants, a majority were employed in the Government Sector, while a lesser number of participants were employed in the private sector. These were 47.3% and 14.5% respectively. The unemployed number was 16.4% while 21.8% of the participants were employed as laborers. The majority of participants who sought medical attention at the hospital were from the suburban areas (38.7%), while the number of participants from the urban and rural areas was (30.6%), (Table-1).

Table 1: Demographic Data

Demographic Data	Number	Percentage
Age (Years)		
18-30	30	25%
31-40	26	21.70%
41- 50	30	25%
Over 50	34	28.30%
Gender		
Female	78	65%
Male	42	35%
Educational status		
None	0	0%
1-5 Grades	10	8.30%
Ordinary Level	68	56.70%
Advanced Level	36	30%
Higher Education	6	5%
Professional Status		
Unemployed	18	16.40%
Labourer	24	21.80%
Government Service	52	47.30%
Private Sector	16	14.50%
Business	10	9.10%

Among 120 participants, about 88% were aware about rabies. Seventy nine percent (79%) of the participants believed rabies to be fatal, but 76% of them were of the view that it is a preventable disease, even after the onset of symptoms, which might be due to a lack of conducting awareness programs related to rabies (Hotez et al., 2014). Approximately 60% of the participants had been bitten by rabid dogs (Fekadu, 1988). Considering the results as a whole, most of the participants (80%) had considerable knowledge about rabies, while 12% had a fair idea and 8% had a poor level of knowledge about rabies (Figure-1).

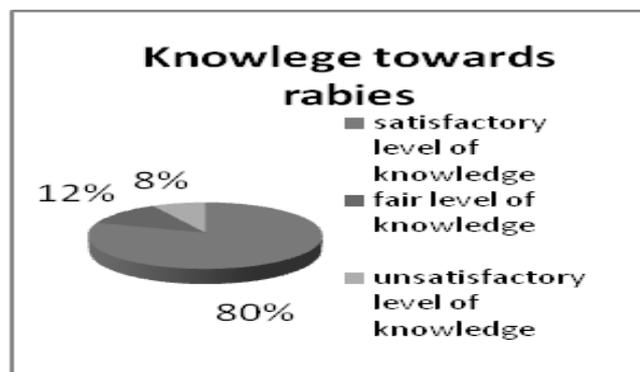


Figure 1: Knowledge of rabies.

A significant majority of participants (88%) revealed that public awareness about rabies was important. Fifty two percent (52%) among the participants stated that dog sterilization is unethical, which might be due to religious misconception and poor knowledge of the subject. This statement can be proved by previous finding (Rupprecht *et al.*, 2007). Some participants (52.5%) were reluctant to provide the head of the dead animal, after an animal bite for the rabies confirmation test (Figure-2). They believed it as an inhuman action, and this may due to lack of knowledge and attitudes. This was similar to previous findings (Dissanayake *et al.*, 2007).

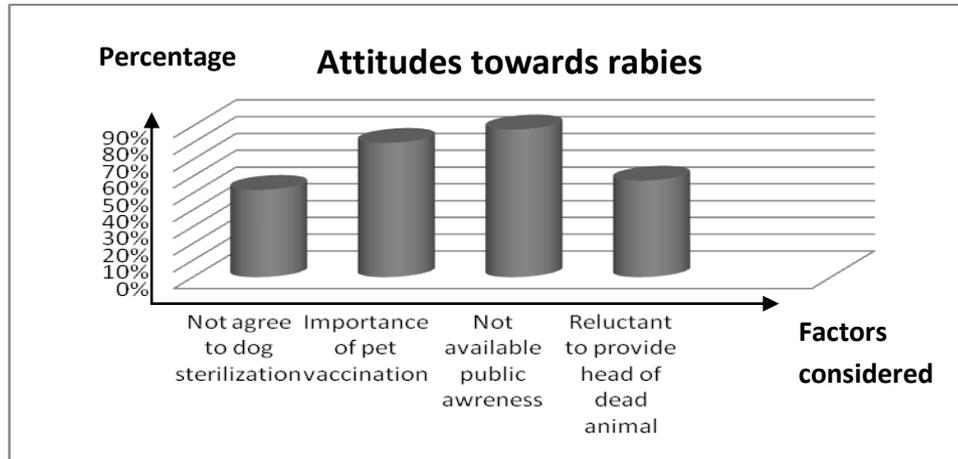


Figure 2: Attitudes towards rabies.

Eighty five percent (85%) of the participants have had treatment from a doctor or from a hospital after being bitten by an animal, but only 70% of them had come for treatment just after an animal bite. This might be due to poverty and lack of coordination with public health officers (Rupprecht *et al.*, 2007). Most of the rural respondents (70%) had no access to vaccination facilities. Poorly organized health care services in rural areas may be a likely cause. Religious misconception, individual life style, lack of awareness about available facilities, poor distribution of awareness programs can be said to be further barriers to preventing rabies. These facts were highlighted by early researches as well. (Dissanayake *et al.*, 2009).

CONCLUSIONS/RECOMMENDATIONS

The findings of the study illustrated that the awareness and receptiveness to rabies control measures are high. The view of the nature of the disease, educational attainment, facilities for vaccination and professional status were mostly affected by the knowledge, attitudes and practices among patients with animal bites. Further, poor distribution of mass awareness programmes, and lack of facilities has affected the knowledge, attitudes and practices about rabies in rural areas. According to the study results, religious misconception, irresponsible pet ownership, poverty, lack of coordination with public health officers and unorganized health care providing services related to rabies in rural areas are the barriers to preventing rabies in Sri Lanka.

Implementing public awareness programs is essential. Further, education campaigns must be enhanced to increase the knowledge level of the public. The nature of the disease and preventable measures must be further highlighted in public education by the media. Community health activities need to focus on rural areas and coordination of public health activities must be further developed. Furthermore, there is a need to improve coordination among Regional Public Health authorities and veterinary services. Rabies control measures such as mass dog rabies vaccination must be developed. There is a difference in the attitudes and pet care practices relevant to rabies control between urban and rural areas. Pet owners tend to be more cooperative to rabies control activities. Furthermore, the attitudes and

practices of the respondents in the study reflect the inaccessibility of facilities and the lack of services that would facilitate greater participation in rabies control.

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QUALITY OF LIFE OF A PATIENT WITH GLAUCOMA

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INTRODUCTION

Glaucoma is a group of progressive optic neuropathies that lead to severe restriction of the visual field and irreversible blindness which subsequently reduces the Quality Of Life (QOL) (Nelson *et al.*, 2003). QOL is an indicator of a person's overall wellbeing which includes dimensions of physical and mental health, social functioning and independence. In simple terms; it is the ability to pursue a happy and fulfilled life (Skalicky & Goldberg, 2013).¹ Although the components of a good QOL differ among individuals and societies, vision has consistently been demonstrated as one of its key determinants (Speath, Walt & Keener, 2006). A sizable and growing body of evidence clearly shows that patients value their vision more highly than most ophthalmologists realized (Sprta, Kotecha & Visvanathan, 2008).

By 2020, 79.6 million people worldwide will have either open-angle or angle-closure glaucoma and 11.2 million will be bilaterally blind (Quigley & Broman 2006). Around 87% of visually impaired people live in developing countries (Abba, 2009), where eye health care provision is desperately inadequate. Glaucoma accounts for 6% of all cases of blindness in Sri Lanka (Oduntan, 2005) However, the actual morbidity figures could be much higher, since no proper study has yet been conducted in this country. Therefore, the purpose of this study is to identify the influences of glaucoma on the quality of life while identifying the patients' knowledge and attitudes regarding the disease, examining the problems and difficulties faced by them and assessing how an individual adapts to life with glaucoma.

METHODOLOGY

Qualitative approach and phenomenological design were used for the study. Phenomenological design is recommended to identify how people actually perceived or sense a situation. In the human sphere, this normally translates into gathering 'deep' information and perceptions through inductive, qualitative methods such as interviews, discussions and participant observation, and representing it from the perspective of the research participant(s).

Ethical approval was granted from the ethical review committee of the National Hospital of Sri Lanka and the study was undertaken for 12 purposively selected patients who were medically fit and willing to participate voluntarily. At the time of each interview, written and verbal explanations were provided and consent forms were obtained. All patients were assured that their identities would not be disclosed anywhere. Each interview was tape recorded and took approximately 30 minutes. An interview theme list was used to elicit information and gathered data were analyzed based on thematic analysis. Knowledge about the disease, physical disabilities and psychological impact of the disease immersed as themes.

RESULTS AND DISCUSSION

All the selected patients were over 40 years of age and from urban areas. Glaucoma not only affects the visual function but also has a burden on overall health of the patient and his/her

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quality of life. This influence begins on the date of diagnosis of the disease, initially due to the patient's fear of blindness and subsequently due to the development of the disease which involves a progressive reduction of daily activities and loss of self-confidence. Knowledge deficit, physical impairment and unsatisfying daily life were found to impair the QOL of glaucoma patients.

The immediate feelings of most of the patients on hearing about glaucoma, were that of fear, disappointment and helplessness. Such negative perceptions were more frequent among patients above 50 years of age. That is basically due to the lack of awareness and knowledge deficiency about the disease. These psychological influences of having glaucoma were similar to the findings of the study in United States of America (Spaeth & Birbilis 1991). As stated by patient P2,

..... "I did not know anything about glaucoma before coming to the clinic. I was afraid and stressed with the diagnosis and felt very sorry about myself when the doctors say condition is controllable if it was diagnosed early. Every day I feel guilty about myself because if I have gone for treatments early my vision would have better than now."patient P2

A lack of understanding about the disease was the primary cause for delay in seeking treatment, resulting in the condition being worsened. Some people heard the word "glaucoma" for the first time at the diagnosis. This clearly showed that knowledge of the disease was lacking. Similar results were highlighted by Attebo *et.al.*(1997) in New Zealand and Australia. In order to increase the general awareness, it is required to perform education sessions not only at the clinic but even at the Out Patient Department (OPD). As stated by Spaeth (1997), improved understanding would help the patients to better manage their disease. Even a brief education program could improve levels of knowledge of glaucoma, but according to Kim *et.al.*(1997), patient education must be repeated to have the desired effect.

The physical impairments experienced by most patients were inability to read, drive, cross the road and climb staircases.. Patients with bilateral vision loss experienced more severe difficulties than others. They could not engage in their preferred daily tasks as before. One patient expressed concern about reading.

..... "I am facing too many difficulties during glaucoma. Even I can't read the headline of a newspaper. For that simple thing now I have to depend on someone else, when everybody busy with their own works I can't force them to do that for me. It is difficult for me to enjoy my day to day activities since reading newspaper was one of my favorite hobbies." ...patient p7

The elderly enjoy reading, since it gives relaxation to their mind. However, many patients experienced difficulty in reading even in the mild stage of glaucoma. This finding was further supported as people with glaucoma complain about difficulty in reading throughout the course of the disease (Nelson, Aspinall, & O'Brien, 1999). Loss of vision is a major cause of activity limitation among the elderly. Physical activities including walking are important to maintain good health in old age, but the vision loss caused by glaucoma severely interferes with this activity.

The psychological impact of loss of vision cannot be ignored. Most patients are unable to work on their own and have become dependent on others. Some feel dejected and have given up on life. Some try their best to do things for themselves, even though they are unable to, so as not to be a burden on their families. Loss of independence is always associated with feelings of helplessness and fear of going blind. These findings were further supported by a study done in China (Wu *et.al.* 2010). One patient was highly frustrated about his life.

.... "I was affected by this disease in my late fifties. Now I am having difficulty to do works on my own. Even to go here to there I have to take help from others. One day they will be fed up

of helping me. No one likes to do the same thing thousand times. I am thinking that I am a fully dependent patient. Near future I'll be blind. It is better to die than live"....patient p5

In contrast, a minority of patients manage to live with the disease with the help of family members. Adjustment to life with glaucoma helps to maintain daily routine with minimum problems, but family support plays a vital role as stated by patient P9,

..... "It was too difficult to adjust the life earlier. Just now I am gradually getting used to living with the disease. Sometimes my family helps me to do the things that I cannot do for myself. Actually my daughter totally re arranged the furniture setup of my house. Earlier my room was upstairs but now I'm living downstairs and no need to take a risk of climbing staircase".....patient p9

These findings were further supported by a similar study done in China (Wu *et.al.* 2010). Double-checking an object's position, improving household lighting, avoiding staying out in the dark, and wearing hats outdoors to reduce the lighting difference will help to manage the impact of the disease in day to day life (Wu *et.al.* 2010). Patients need considerable care and attention and the support of others.

CONCLUSIONS/RECOMMENDATIONS

This study offers a better understanding of the life with glaucoma, a condition that people do not show much concern for until they they are affected by it. The quality of life is severely affected by physical and mental impairments caused by the disease. However, the findings revealed that knowledge about glaucoma was lacking and so early diagnosis was limited. Frequent problems related to decreased vision were identified such as reading, walking on stairs and crossing roads. Difficulties with these activities were more often reported by the older patients. Although a few patients adjusted and were able to cope with daily activities with the disease, others were not fully adjusted.

Continuous education about the disease to both patients and public is recommended since early diagnosis provides more control of the disease with the use of medication. Knowledge and information regarding the disease would be useful in several aspects including customized disease management and promotion of alterations regarding patients' daily living and safety. Furthermore, arrangements should be made to give patients the appropriate emotional and physical support from family members. Care takers also should be well informed about the disease along with efficient patient management.

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SCHOOL CHILDREN'S KNOWLEDGE, ATTITUDES AND BELIEFS REGARDING STIs/HIV; A DESCRIPTIVE STUDY IN RURAL SETTINGS

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INTRODUCTION

The Human Immunodeficiency Virus (HIV) is one of the most serious, deadly infectious viruses in human history. HIV transmission and acquisition is known to be facilitated by Sexual Transmitted Infections (STIs). STIs are infections including HIV that spread primarily by sexual contact through person to person (WHO, 2013). It is estimated that within a period of 24 hours, around 7000 people are infected with HIV and more than a million exposed to sexually transmitted infections (STIs) worldwide. Today, 23% of all people living with HIV are under the age of 24, while 35% of all new infections happen among people between 15-24 years of age (Engenderhealth, 2013). Many adolescents around the world who are sexually active engage in unprotected sex. Therefore, they are at a risk of possessing sexually transmitted infections including HIV (Jaiswal *et al*, 2005).

The first case of HIV infection in Sri Lanka was reported in 1987. Since then a total of 1196 HIV infection and AIDS cases have been cumulatively reported in the country. At the end of December 2012 there were 9309 new cases of STIs and 395 new cases of HIV reported among those between 19-29 years of age (NSACP/SIM/2012). From these statistics it is clear that adolescents have a higher risk of getting infected with STIs and HIV. Though the knowledge of adolescents is an important preventive factor of STIs and HIV, school students do not have sufficient knowledge about the symptoms, complications, transmission and risk group of this deadly infection (Anwar *et al*. 2010). Therefore, the school authorities and others concerned should come forward to design awareness campaigns for school children, and help them to improve their knowledge of HIV and STIs, as well as their spread and prevention. Further, given its deadly nature it is of paramount importance to prevent HIV/STIs among the younger population as it drives youngsters to lifelong suffering, as well as wasting the country's wealth.

In the health care system in general, prevention is the more economical measure to reduce the health cost in a country. Modern technology is widely used to prevent STIs/HIV present worldwide. In Sri Lanka, some rural settings still do not even have facilities such as electricity. But according to the statistics of the National STIs and AIDS control programme, rural settings like Kurunegala and Anuradhapura have reported a higher number of cases of STIs/HIV.

The scarcity of the relevant Sri Lankan literature on HIV/STIs stresses the need for conducting a study to assess the school adolescent's knowledge, attitudes and beliefs of HIV/STIs. Therefore, this study focused on examining the current knowledge, attitudes and beliefs of adolescent school children regarding HIV/STIs in rural a setting which is of paramount importance in order to identify their learning needs. The specific objectives of this study were to identify the current available resources for school children in rural settings, and to examine the perceived barriers among students to improve their knowledge regarding STIs/HIV.

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METHODOLOGY

Using the quantitative approach, this descriptive study was conducted in Anuradhapura and Kurunegala districts as rural settings in January 2014. Two National mixed Sinhala medium schools were randomly selected from each district. A total of 150 students were initially randomly selected using the school class room registers of Advance Level classes. Of these students 148 students answered the questionnaire completely. The response rate was 98%.

For data collection, a pretested and validated self-administered questionnaire with 15 items was used. The questionnaire comprised of six sections which were according to the study objectives: socio-demographic data, knowledge related to STIs and HIV/AIDS, sources of getting information, attitudes and beliefs regarding STI and AIDS, and perceived barriers to improve knowledge of HIV/AIDS and STIs.

Ethical clearance was obtained from the ethical review committee of the National Hospital of Sri Lanka. Permission was taken from the principals of the selected schools to conduct the study. Informed consent was taken from parents of student who voluntarily participated. Data were analyzed by using descriptive statistical method. (Microsoft excels windows 08). Data were expressed as quantities and percentages of students.

RESULTS AND DISCUSSION

A total of 150 students participated in the study, of these, 148 students completely answered the questionnaire. The Socio-demographic characteristics showed that the most frequently reported age group was 18 years, and most of these students were Buddhists (90.8%).

Table1: Socio demographic data

Socio-demographic data		Total (no=148)	
Characteristica		No	%
Age			
	16 years	6	4
	17 years	39	26
	18 years	98	66
	19 years	5	3
Sex			
	Male	53	35
	Female	95	64
Religion			
	Buddhist	136	92
	christian	6	4
	Islam	2	1
	Hindu	4	3
Study section			
	Art	70	47
	Science	78	53

When considering knowledge related to STIs and HIV/AIDS, the majority of respondents 130 (87.8%) had not heard about STIs, whereas all students had heard about HIV/AIDS (100%). Similar findings were reported by Manus and Dhar (2008), concluding that adolescent girls had not heard about STI conditions like Syphilis, Herpes and Chlamydia. Regarding the knowledge of the modes of transmission of HIV/AIDS the majority of students correctly identified that unprotected sex (99%), blood transfusion (92%) and injecting illegal drugs (84%) as modes of disease transmission. On the other hand, a minority of students (8.1%) knew that road traffic accident and (16%) that tattooing were also modes of transmission of HIV/AIDS (Figure-2). Gupta, *et al* (2013) found that secondary school students in India had known that unprotected sex, blood transfusion and injecting illegal drugs are modes of transmissions of HIV/AIDS. But knowledge about road traffic accidents and tattooing were not inquired by the study.

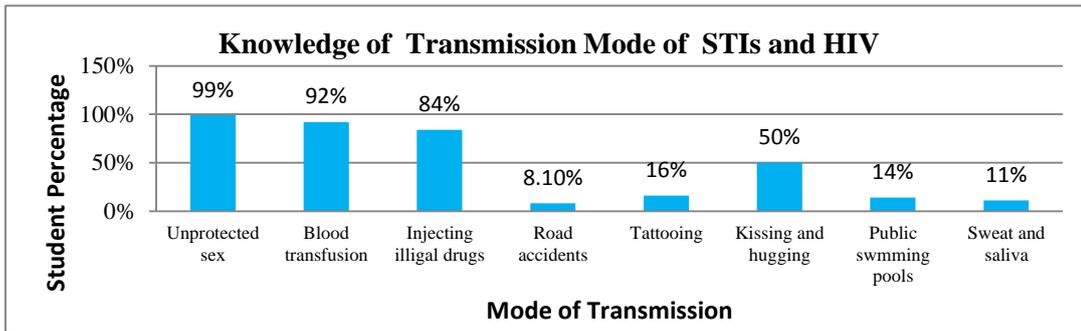


Figure-2 Knowledge of mode of transmission of HIV/AIDS in rural setting students.

Regarding high risk groups, 64% students pointed out that adolescents were a high risk group, but a total of 30 (20%) students had not indicated drug addicts as a high risk group. Gupta *et al* in India observed that the knowledge of students about high risk group of STIs/HIV was not satisfactory in year 2013. When considering HIV prevention and control, 110 (74%) students had known that usage of contraceptive pills is not an effective method of preventing HIV. Only 53% of the participants knew that using condoms was an effective method of preventing HIV/AIDS and other STIs respectively (Figure-3).

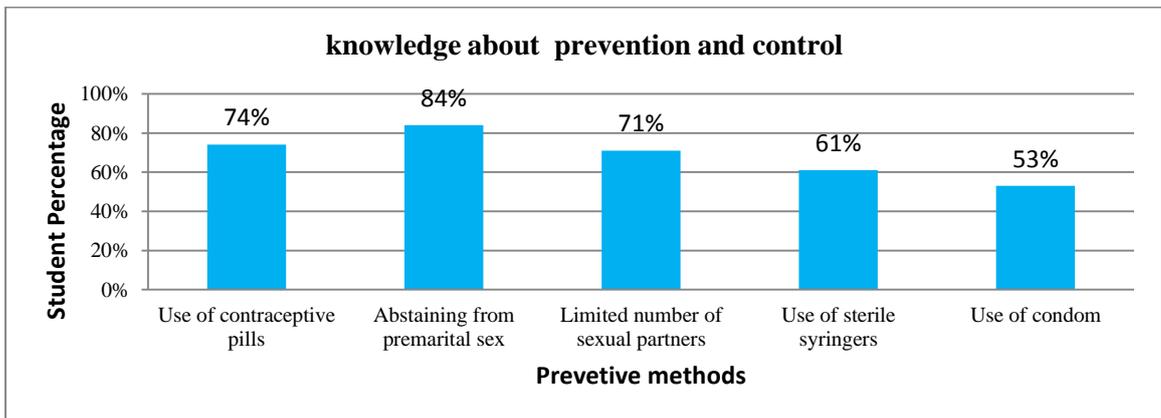


Figure 3: Knowledge on prevention and control of STIs/HIV among adolescent.

The main sources of information available for respondents about HIV/STIs were newspapers (97.9%), seminars (75.6%), books (85.1%) and doctors and nurses (89.1%). Of the sample, 51.3% students had mentioned friends as a source of acquiring information. Most of the students had not marked Internet and TV shows and movies as sources of acquiring information (Figure 4). In contrast, Gupta *et al* identified that the majority of students (85%) in India get information on HIV/AIDS from the television.

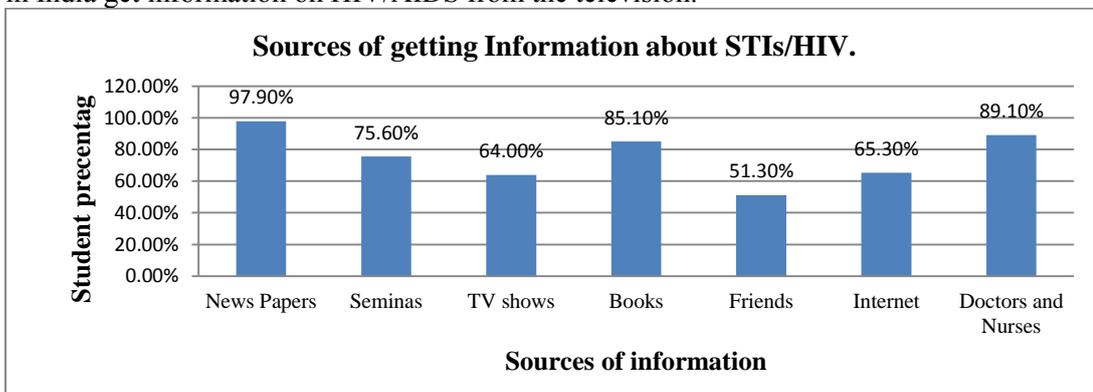


Figure 4: Sources of getting information about STIs/HIV

Many students had relatively good attitudes and beliefs towards people with HIV/AIDS (70.8%). Of the sample 44.5% of students had barriers to improve knowledge regarding STIs/HIV such as a lack of audio visual media to get knowledge, cultural barriers to discuss HIV, embarrassment regarding inquiring about STIs/HIV conditions, reluctance on the part of elders to give knowledge, fear to discuss the topic openly, teachers refusing to explain and not conducting seminars or lectures.

CONCLUSIONS/RECOMMENDATIONS

In spite of the efforts over the past years in STIs and HIV prevention, this epidemic still presents a serious challenge to societies around the world, including Sri Lanka. The findings of the study clearly reveal that improved knowledge among students will enable them to take steps to prevent contracting STIs/HIV, and reduce the stigmatization of living with AIDS with the help of others. Cultural barriers, system of education and lack of health education programmes were the main barriers to improve knowledge of adolescents in rural settings.

The study shows that there is a need for disseminating appropriate information, using education and communication strategies for increasing awareness about STIs/HIV. Health education programmes, seminars and public talks regarding STIs/HIV and AIDS prevention should be conducted regularly in schools with the support of the health education units of hospitals. Parents and teachers should be targeted when conducting educational activities, this would enable them to play a beneficial role in creating awareness among the younger generation on the sex, STIs/HIV and AIDS.

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ATTITUDES TOWARDS ELDERLY CARE AMONG FINAL YEAR NURSING STUDENTS OF THE UNIVERSITY OF SRI JAYEWARDENEPURA AND THE NATIONAL SCHOOL OF NURSING SRI JAYEWARDENEPURA

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INTRODUCTION

The elderly population in Sri Lanka is rapidly increasing (De Silva, 2007). The growing number of elderly population increases demands on the public health system and on medical and social services. Furthermore, it requires expansion of nursing services for the elderly (Kim *et al.* 2004). Research reveals that there are many problems which are faced by the elderly people in hospital care in Sri Lanka and there is a shortage of nurses who are specialized to provide geriatric healthcare (Balasuriya, 2009).

Nurses, have a special role as providers of care for older people and are in a unique position to influence the quality of care. The quality of care provided for older people is directly related to the attitudes of the nurses and nursing students who are involved in it (Hweidi & Al-Obeisat, 2006). Hence, it is important to promote positive attitudes among students towards the elderly, apart from knowledge and skills, thereby enhancing the quality of nursing care to meet the current and future nursing needs of an aging society.

The purposes of this study was to determine the attitudes towards Elderly Care and to describe the possible factors associated with such attitudes of final year nursing students of both institutes and to describe the teaching and learning content of elderly care in both nursing curriculums of The University of Sri Jayewardenepura and The National School of Nursing Sri Jayewardenepura. Identification of possible associated factors for attitudes may also help make suggestions to improve the quality of nursing care for the elderly. The findings of this study will further help as reference data for future research studies.

METHODOLOGY

A descriptive and analytical study design was used for this study. The study was conducted in The University of Sri Jayewardenepura and The National School of Nursing, Sri Jayewardenepura as they are identified as two main institutions that project nurses into the health sector in the Western Province of Sri Lanka. All the final year nursing students from both institutions who volunteered were included in the study. An informed written consent was taken from the participants. A pre tested, self-administered questionnaire consisting of closed ended and open ended questions was used to assess the attitudes towards the elderly care and the possible factors associated with such attitudes among final year nursing students. An interview was conducted with the head of the nursing program of each institute to obtain information regarding the content of the nursing curriculum dealing with elderly care. It is believed that exposure to elderly care during the training is associated with improved attitudes in students towards them. Some studies also have identified a positive correlation between working experience with older people and an intention to work with them (Shue *et al.*, 2005). Informed consent was taken from both heads of nursing programmes. Data collection was conducted during the month of October, 2013.

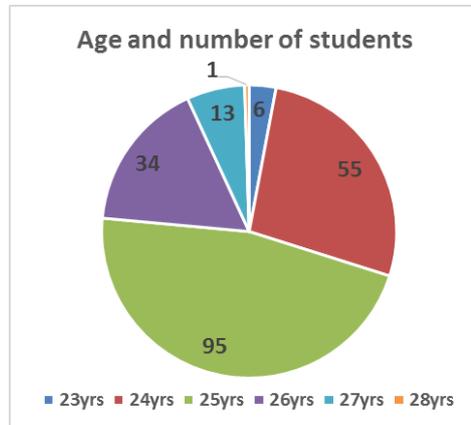
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Ethical approval was obtained from the ethical review committee of the Faculty of Medical Sciences, University of Sri Jayewardenepura. SPSS 16.0 was used to analyze the data.

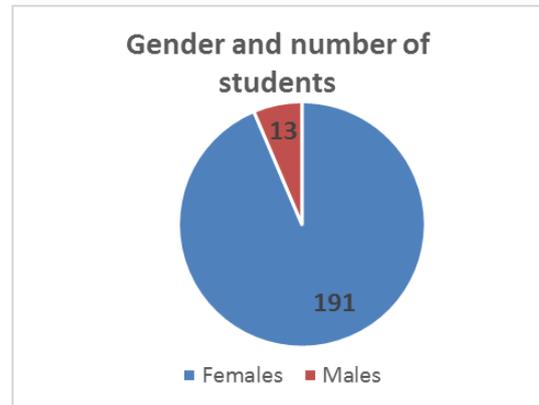
RESULTS AND DISCUSSION

A total of 204 of 249 nursing students responded (81.927%). The majority of the study group were of the age of 25 years (46.6%; n=95) with the mean age of 24.98 + 0.065 (SD: 0.926, X^2 : 0.857). A total of 191(93.6%) subjects were females (Figures 1a, 1b, 1c).

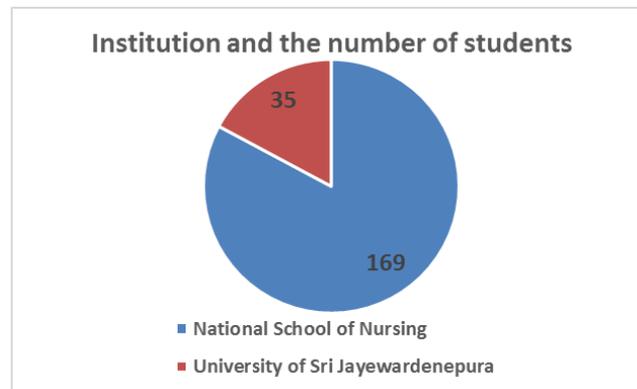
1a



1b



1c



Figures 1a, 1b, 1c: Distribution of the respondents according to socio-demographic characteristics (N=204)

The attitude towards the elderly care was determined by the response to 14 statements (Table 1). Participants were asked to indicate on a 5-point Likert scale, how strongly they agreed or disagreed with each of 14 statements (1= Strongly disagree, 2=Agree, 3=No Idea, 4=Disagree, 5=Strongly disagree), resulting in scores ranging from 14-70 with higher scores indicating positive attitudes (43-70) and lesser scores (14- 42) indicating negative and neutral attitudes towards the elderly care. The questions numbers 2, 7, 8, 9, 10, 11&12 were reverse scored.

Table 1: The statements used to describe the attitudes towards elderly

Variable	Strongly Agree	Disagree	No Idea	Agree	Strongly Agree
1 I prefer to work with older patients, Than others.	1 (0.5%)	39 (19.1%)	51 (25%)	104 (51%)	9 (4.4%)
2 I consider caring for the elderly a Challenge.	2 (1%)	47 (23%)	24 (11.8%)	109 (53.4%)	22 (10.8%)
3 I consider it as an opportunity to help old patients and their families.	4 (2%)	4 (2%)	11 (5.4%)	147 (72.1%)	38 (18.6%)
4 I always try to be patient, cheerful and sensitive towards older patients.	2 (1%)	8 (3.9%)	14 (6.9%)	108 (52.9%)	72 (35.3%)
5 I always empathize with them.	2 (1%)	3 (1.5%)	21 (10.3%)	125 (61.3%)	53 (26%)
6 I am ready to spend extra time with the old patients if needed.	4 (2%)	11 (5.4%)	30 (14.7%)	132 (64.7%)	27 (13.2%)
7 I dislike caring for elderly people because they are psychologically and physically fragile .	82 (40.2%)	92 (45.1%)	17 (8.3%)	12 (5.9%)	1 (0.5%)
8 I like to care for older patients only if they are cheerful, agreeable, and good humored.	25 (12.3%)	94 (46.1%)	30 (14.7%)	47 (23%)	8 (3.9%)
9 When caring, it is difficult to get the support of elderly, because they are stubborn.	7 (3.4%)	81 (39.7%)	47 (23%)	64 (31.4%)	5 (2.5%)
10 It is very hard to care for older patients as they are irritable, grouchy, and unpleasant.	53 (26%)	109 (53.4%)	18 (8.8%)	21 (10.3%)	3 (1.5%)
11 Caring for elderly gives the least satisfaction.	41 (20.1%)	52 (25.5%)	26 (12.7%)	56 (27.5%)	29 (14.2%)
12 I consider, in order to maintain a well organized clinical setting, it would be better if there are only young patients.	35 (17.2%)	43 (21.2%)	52 (25.5%)	60 (29.4%)	14 (6.9%)
13 I consider, the knowledge and the clinical experiences gathered during the nurses training programme are adequate to care for the elderly in hospital and in society.	12 (5.9%)	31 (15.2%)	19 (9.3%)	122 (59.8%)	20 (9.8%)
14 I consider, the nurses must be knowledgeable and skilled when participating in elderly care.	10 (4.9%)	11 (5.4%)	10 (4.9%)	100 (49%)	73 (35.8%)

Most of the students reported positive attitudes towards the elderly care scoring between 43-70 (n=179; 87.7%) compared to students (n=25; 12.3%) who reported negative and neutral attitudes (scoring 14-42). The average score of the participants was 50.43 while minimum and maximum scores were 36 and 63 respectively.

In many of the other studies, it was found that the attitudes of nurses towards elderly and elderly care generally were positive (Kang *et al.*, 2011; Matsui & Braun, 2010). The results of this study agree with the findings of other studies. It is a positive fact in relation to elderly care among nursing students when confronting the demands of the increasing elderly population.

Possible associated factors with attitude levels were analyzed by demographic characteristics of the participants and the responses to four close ended questions. It was observed that the sex of the student is not associated with the attitude ($p=0.722$; $p>0.05$). Similarly the experience of having grandparents ($p=0.205$; $p>0.05$), the experiences of grand parents living with the students ($p=0.87$; $p>0.05$) and the experiences in caring for grandparents at their homes ($p=0.793$; $p>0.05$) were also not associated with students' attitude. However, there was significant association between the level of attitudes and the experiences in caring for the elderly in clinical settings such as in hospitals ($p=0.044$; $p<0.05$). (Table 2)

At the end of the questionnaire there was an open ended question asking the students about their views regarding the content of geriatric nursing in the curriculum of nursing. Marked percentage of (68%) students preferred to have a separate subject for geriatric nursing within their curriculum.

Many other studies have shown that there are several independent variables that influence students' attitudes, as gender, age and education (McDowell *et al.*, 1999; Soderhamn *et al.*, 2001). Some studies have identified a positive correlation between working experience with older people and an intention to work with them (Shue *et al.*, 2005). The present study also shows a significant association in nursing students who had experiences with elderly in a clinical setting, with positive attitudes towards them. It highlights the importance of exposure of students to clinical/working environments of elders to cultivate positive attitudes.

Table 2: The associations between the attitude levels and the associated factors

	Attitude		P value
	Negative	Positive	
Sex			
Female	23(12.04%)	168(87.95%)	0.722
Male	2(15.38%)	11(84.61%)	
Experience of having grandparents			
No	4 (7.4%)	50 (92.6%)	0.205
Yes	21 (14%)	129 (86%)	
Experience of living with grand parents at home			
No	7 (9.2%)	69 (90.78%)	0.87
Yes	14 (18.91%)	60 (81.08%)	
Experience of caring grand parents at home			
No	10 (13.15%)	66 (86.85%)	0.793
Yes	15 (11.9%)	111 (88.09%)	
Experience of caring elderly in clinical setting			
No	8 (22.22%)	28 (77.73%)	0.044
Yes	28 (77.73%)	151 (89.88%)	

The interview with the Head of the nursing program of the University of Sri Jayewardenepura and the Principal of the Nurses' Training School of Sri Jayewardenepura revealed that there are no designated subjects to teach Geriatric Nursing in the present nursing curriculums. However, some material related to elderly care is taught in the medical and surgical modules dealing with diseases. The nursing students are most exposed to elderly patient care in the general wards during the clinical attachment and community field visits to elderly homes. Nonetheless, there are no assessments or evaluations of student performance in this area.

In literature, to name a few, King & Cobb in 1983 and Sheffler in 1998 have discussed the need for more gerontologic content in nursing programs such as a separate subject for elderly care, allocated hours for tutorials, practice in clinical settings and evaluations. The literature more emphasis on gerontological curricula and training in nursing programs are strongly needed. (Celik, 2009)

CONCLUSIONS/ RECOMMENDATIONS

This study shows positive attitudes towards the elderly care among the majority of final year nursing students of the University of Sri Jayewardenepura and the National school of Nursing Sri Jayewardenepura. A significant association between students' previous experience of elderly care in clinical setting, and positive attitudes was observed. It was evident that there are no designated subjects or assessment processes in geriatric nursing in the curricular. Although students generally have positive attitudes, it is suggested to introduce designated 'Geriatric Nursing' hours with more clinical exposure to improve nursing students' attitudes. This may in turn enhance the knowledge and practical skills of the students; a growing need in the future. In addition, it is recommended to conduct similar studies in other nurses training institutions in Sri Lanka to perceive the holistic data.

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KNOWLEDGE AND PRACTICES REGARDING HEALTHCARE WASTE MANAGEMENT AMONGST SANITARY WORKERS IN TWO HOSPITALS IN SRI LANKA

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INTRODUCTION

Health-care waste can be defined as the waste generated by healthcare establishments, research facilities, and laboratories. Waste produced in healthcare institutions can be categorized as non-risk (non-hazardous) and risky (hazardous) waste. Between 75- 90% of the waste is non-risk or general healthcare waste, comparable to domestic waste. The remaining 10-25% of healthcare waste is regarded as hazardous and may create a variety of health risks including the spread of highly contagious diseases (Pruss *et al*, 1999). If not managed properly, large volumes of Health Care Waste (HCW) could further contribute to air, water, and soil pollution and contribute to the emergence of antibiotic resistant strains. The spread of HIV, Hepatitis and other infectious disease that can be caused by needle-stick injuries and other forms of contamination can result from the improper management of healthcare waste by health care institutions (Sachan *et al*, 2012).

The National Environment Act (NEA) of No. 47 of 1980, with its amendments, is the basic legal document that regulates the management of hazardous waste in Sri Lanka (Central Environment Authority (CEA), Sri Lanka. 2008). In addition, on 1st February 2008, a Gazette notification announced the necessity for all health institutions in the country to obtain a license for Health Care Waste (HCW) Management (HCWM). Later, the Ministry of Health, jointly with the CEA, took the initiative to implement HCW-M plans in all health institutions in the country commencing from central and provincial institutions. However, there is no policy on the qualifications required to recruit sanitary workers in the private sector. In order to appropriately implement the HCW management plan, having knowledge in this regard is of paramount importance. In 2013, after five years of implementing these plans, it is important to assess the current status of knowledge, attitudes and practices of sanitary workers engaged in health care waste management.

The objectives of this study are to assess the knowledge and practices of sanitary workers in health care waste management, to find whether there is a difference in knowledge between workers attached to government and private sectors and to compare practices between the Base Hospital (BH) at Wathupitiwala and the General Hospital (GH) at Ratnapura.

METHODOLOGY

A cross-sectional study design was used. The study group was a convenient sample of 150 (males /female, government and private sector) sanitary workers at both the GH at Ratnapura and the BH at Wathupitiwala. Workers who have working experience of more than three months were included in the study. The response rate was 98.67%. It was composed of 63

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workers from the private sector and 37 workers from the government sector in the provincial GH at *Ratnapura*, and 35 from the private sector and 13 from the government sector in the BH at *Wathupitiwala*. All pregnant mothers, sick people and supervisors were excluded. Self administered questionnaires were used as the data collection tool. The media of instruction were Sinhala and Tamil.

The questionnaire consisted of 27 closed ended questions under the three sub headings a demographic data, knowledge on HCW, and current practices related to healthcare waste management. The section on knowledge on HCW included 10 closed ended questions where the participants were able to score a maximum of 14 marks. The comparison of knowledge scores of the two groups was done using Z- test. A p value of 0.05 was considered as statistically significant. The practices were evaluated based on the percentage of responses received for 14 closed ended questions. Ethical clearance was granted from the Ethical Review Committee, Colombo South Teaching Hospital.

RESULTS AND DISCUSSION

The number of female participants was 3.5 times the males. The majority of the study group were around 31-50 years in age. Around half of the group had educational qualifications higher than G.C.E. O/L. Five of the participants had never had formal education.

Knowledge on health care waste management

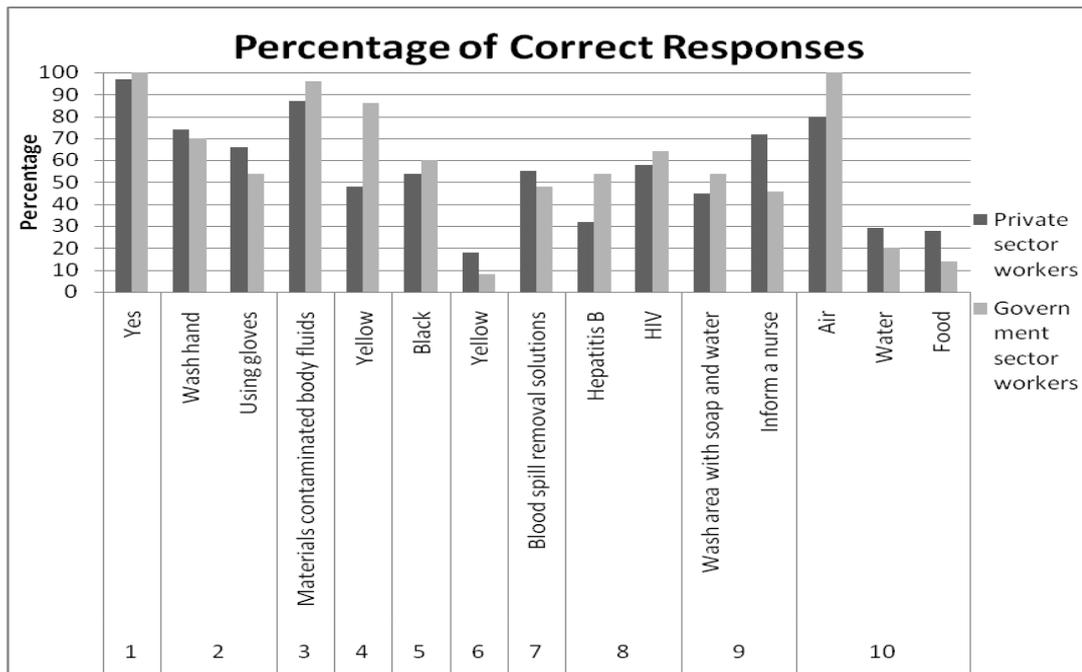
Knowledge regarding general information about HCW is assessed as scores between 0-15. (Table 1). There is no statistically significant difference ($p= 0.3609$) in knowledge scores between the two groups of sanitary workers.

Table 1. Knowledge scores of private and government workers

Scores	Private sector N=98		Government sector N=50	
	No.	%	No.	%
0-4	11	11.22%	0	0
5-10	75	76.53%	43	96%
11-15	12	12.24%	2	4%
Avg. score	7.929		8.200	

More than 90% of the workers from both sectors knew that improper cleaning may spread diseases (Figure 1). A higher percentage of private sector workers than government sector workers knew that washing hands and using gloves can be used as preventive measures for the spreading of infections. More than 85% of the participants were aware that materials contaminated with body fluids have a high risk for transmitting infection. However, these findings are contradictory to the findings of the study conducted by Mustafa *et al* (2011). They revealed that 15% had knowledge regarding pathological waste and 3% have knowledge of usage of gloves, masks and shoes for cleaning.

Knowledge on color codes that are used in the separation of types of waste is unsatisfactory among private sector workers. Knowledge on color codes for sharp materials disposal is very unsatisfactory in both groups. It may be because of the wrong practice of using red colored waste bags for the disposal of sharps. Only about half of the study group was aware about the most suitable agent for disinfecting and removing blood spills. Similarly, the findings of the study carried out by Narang (2012) indicated that only 9% of sanitary workers were aware on the proper removal of blood spills. The fact that needle prick injury may cause HIV and Hepatitis was known by only about half of the participants. A similar result in which 17% had a poor knowledge in this regard was reported in the study by Chaudri *et al* (2004).



1=Improper cleaning may spread other disease; 2=To prevent infection you can; 3=High risk for transmitting infection; 4=Color code for disposing body fluids; 5=Color code for disposing general wastes; 6=Color code for sharp material disposal; 7=Most suitable agent for disinfecting and removing blood spills; 8=Needle prick injury may cause; 9=After needle prick injury you must; 10=Ways of transmitting infections are

Figure1. Knowledge on health care waste management

Practices regarding health care waste management

In both hospitals, around 75% of participants routinely work in the same unit of the hospital. Similar to the study by Samarakoon and Gunawardena (2011), only about one third (36.5%) of the nursing officers had received training on HCW management, the training status of workers was better in the GH at *Ratnapura* than in the BH at *Wathupitiwala*. The results revealed the undesirable practice of cleaning uniforms by the workers themselves at home from both hospitals. This is a main source of spreading infections throughout the environment. The practice of discarding urine and sputum and the frequency of changing waste bags was poor in the GH at *Ratnapura* than in the BH at *Wathupitiwala*. The frequency of cleaning toilets and bathrooms and getting adequate accessories for cleaning were relatively good at the GH at *Ratnapura* than in the BH at *Wathupitiwala*. The practices on transportation and storage of waste were better in the BH at *Wathupitiwala* than in the GH at *Ratnapura* (Table 3).

Although 76% of the workers in the GH at *Rathnapura* were vaccinated against Hepatitis B, only 35% of those at the BH at *Wathupitiwala* were vaccinated. Needle stick injury were reported by 37% of all the workers, 9% of whom were not vaccinated for Hepatitis B infection before injury. A study conducted by Jaroon *et al* (2009) indicated a different finding. Their analysis revealed that overall 62.07% of health care workers were completely vaccinated, 12.64% were partially vaccinated, while 25.29% were not vaccinated against Hepatitis B.

CONCLUSIONS/ RECOMMENDATIONS

The knowledge of sanitary workers is at an average level. There is no difference in knowledge levels was observed between the two categories; private and government. Training

status, adequacy of cleaning devices, the modes of discarding urine and sputum, frequency of cleaning toilets and bathrooms, frequency of changing waste bags are better practiced in the GH at *Ratnapura* than in the BH at *Wathupitiwala*. The practices on transportation and storage of waste are better practiced in the BH at *Wathupitiwala* than in the GH at *Ratnapura*.

It is important to organize awareness programmes addressing sanitary workers to improve knowledge on HCW management. There should be a mechanism to identify training needs, provide relevant training and evaluate practices after training. Furthermore, there should be a policy which should be implemented when outsourcing sanitary workers for the health care institutions. The major malpractice of washing uniforms at home should be corrected as soon as possible.

Table 3. Practices on HCW

Practice	GH Ratnapura	BH Wathupitiwala
Training status- Yes	38%	21%
Gloves usage- Yes	97%	94%
Frequency of using gloves- Every time	67%	71%
The uniform is cleaned by- Own	0%	2%
Wearing uniform- Before starting work:		
	88%	96%
Adequacy of cleaning devices- Sufficient	85%	77%
The mode of discarding urine and sputum- To separate place at ward	35%	15%
Any time when dirty	80%	58%
Frequency of changing waste bags- At filling the dust bin	33%	25%
Maintaining cleanliness of Mop- Wash by soap & water& dry	83%	92%
Transportation and storage of waste- Different carts to different stores	77%	85%

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VENTILATOR ASSOCIATED PNEUMONIA: NURSES' PERSPECTIVE

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INTRODUCTION

Ventilator Associated Pneumonia (VAP) is the most common nosocomial infection, with the prevalence rates ranging from 10% to 70% in critical care units (Ruffel, 2008). VAP occurs in people who are on mechanical ventilation through an endotracheal or tracheotomy tube for at least 48 hours (Ruffel, 2008). In spite of extensive worldwide efforts implemented to prevent and treat for VAP, a mortality rate of approximately 30% still exists (Ruffel, 2008).

In addition, VAP is a major health care burden in terms of mortality, escalating health care costs, increased length of ventilator days and length of hospital stay. Although ICU nurses are important stake holders to put VAP preventive strategies into practice as they are at the patient's bedside 24 hours a day (Murnro, 2006) they are usually unaware of evidence based preventive guidelines for VAP, resulting in negative impact on all aspects of patient care. Therefore the nurses' responsibility is to adhere to the VAP preventive guidelines when handling ventilated patients. Thus the identification of nurses' knowledge and practices will help to reduce the mortality of VAP and additional health care costs.

The main purpose of this study is to identify the nurses' perception regarding prevention of VAP. Further this study examines intensive care nurses' knowledge and attitudes towards prevention of VAP and practices on handling ventilated patients in intensive care units.

METHODOLOGY

The quantitative non experimental descriptive study design was used for the study. It was conducted with randomly selected 200 Intensive Care Unit (ICU) nurses at the National Hospital of Sri Lanka (NHSL) and Colombo South Teaching Hospital (CSTH). Ethical approval was obtained from the Ethical Review Committee, National Hospital of Sri Lanka and Colombo South Teaching Hospital.

Pre-tested validated self-administered questionnaire was used to collect data as a tool. It focused on participants' demographic data; nurses' knowledge regarding VAP; the attitudes towards prevention of VAP and the current practices used by nurses when handling ventilated patients. Attitudes regarding ventilator associated pneumonia among nurses were mastered by using the Likert scale. Data was collected from 01st November to 31st December 2013. The response rate was 92%. Data were coded and analyzed by descriptive statistics using SPSS 16.0 version.

RESULTS AND DISCUSSION

According to the demographic characteristics 90.2% of the study participants were female nurses. Majority of the participants (67.4%) had 02-05 year working experience. Further, 20.1% and 9.3% had 06-10 years and more than 10 years working experience respectively. Sixty five percent nurses of the sample comprised of Medical ICUs while 34.8% from Surgical ICUs. With respect to the special ICU training, only 23.9% nurses had such ICU training.

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Majority of the participants (93.2%) were aware of Ventilator Associated Pneumonia.

Table 1: Overall knowledge on Ventilator Associated Pneumonia (N=184)

Level of Knowledge	Number (N)	Percentage
Poor (0 – 06)	16	8.7
Satisfactory (07 – 12)	111	60.3
Good (13 – 19)	57	31.0
Total	184	100.0

Minimum:02 Maximum:17 Mean: 11.67 Standard Deviation: 3.38

Overall knowledge on VAP among nurses was satisfactory (60.3%) (Table 1). Further a study conducted by Labeau *et al* (2007) in Belgium found that nurses lack knowledge regarding VAP. This result is inconsistent with present study as nurses might absorb updated knowledge on VAP from in service education programs organized by hospitals.

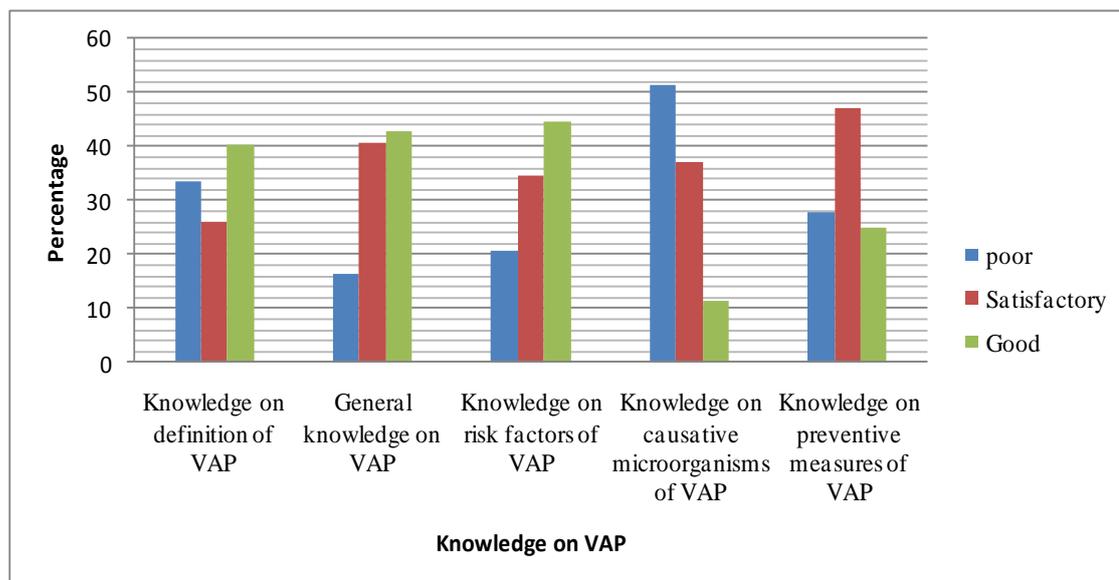


Figure 1: Knowledge on Ventilator Associated Pneumonia

Majority of the participants (40.2%) defined VAP as a nosocomial infection that occurs in patient receiving mechanical ventilation for more than 48 hours. Moreover, participants' general knowledge on VAP was fairly good (42.9%) (Figure 1). Among general knowledge on VAP 85.9% participants knew about mechanical ventilation increases the risk of VAP. In addition, participants' knowledge on preventive measures of VAP was satisfactory (47.3%) (Figure 1). Among knowledge on preventive measures of VAP, 72.3% nurses responded that noninvasive ventilation should be used whenever possible as ideal method of VAP prevention. Further when comparing endotracheal intubation; oral route versus nasal route, most of the participants recommended oral intubation as the correct method to prevent VAP. Furthermore a study conducted by Labeau *et al* (2007) in Belgium found that ICU nurses' knowledge on intubation was adequate to prevent VAP. This result is consistent with present finding as nurses may obtain knowledge from the stipulated ICU patient handling guidelines.

Table 2: Attitude on prevention of Ventilator Associated Pneumonia (N=184)

Level of attitude	Number (N)	Percentage
Poor (0-15)	0	0
Satisfactory (16-30)	09	4.9
Good (31-45)	175	95.1
Total	184	100.0

Attitudes regarding VAP among nurses were good. No participants were reported in the poor category (Table 2). A study conducted by Kiyoshi (2011), regarding nurses' attitudes on prevention of VAP, highlighted that, generally, nurses had positive attitudes and adhered to the guidelines always to most of the time. The primary attitude of nurses regarding VAP was that "prevention is better than cure".

Table 3: Existing practices on handling ventilated patients

Existing practice	Yes		No	
	Number	(%)	Number	(%)
Hand washing				
Before performing patient care	165	(89.7)	19	(10.3)
After performing patient care	168	(91.3)	16	(8.7)
Before handling each new patient	159	(86.4)	25	(13.6)
When hands are dirty	148	(80.4)	36	(19.6)
Changing Ventilator Circuit				
48 hourly	67	(36.4)	117	(63.6)
Weekly	79	(42.9)	105	(57.1)
For each new patient	162	(88.0)	22	(12)
Changing Suction System				
Daily	146	(79.3)	38	(20.7)
Weekly	33	(17.9)	151	(82.1)
For each new patient	128	(69.6)	56	(30.4)
Frequency of tracheal suction				
Frequently	82	(44.6)	102	(55.4)
Weekly	68	(37.0)	116	(63.0)
Minimized and not needed	101	(54.9)	83	(45.1)
When needed	135	(73.4)	49	(26.6)
Patient positioning				
Supine	27	(14.7)	157	(85.3)
Semi recumbent	125	(67.9)	59	(32.1)
Not required	29	(15.8)	155	(84.2)
Frequency of changing humidifiers				
48 hourly	64	(34.8)	120	(65.2)
72 hourly	28	(15.2)	156	(84.8)
Weekly	38	(20.7)	146	(79.3)
Frequency of changing Heat Moisture Exchange				
24 hourly	111	(60.3)	73	(39.7)
After extubation	71	(38.6)	113	(61.4)
At free time	24	(13.0)	160	(87.0)
Never	41	(22.3)	143	(77.7)

Nurses' practice on handling patients in ICU was satisfactory. Practice on hand washing was satisfactory. Majority of participants (89.7%) responded that hand washing was essential

before and 91.3% participants expressed that hand washing essential after performing patient care. Forty two point nine percent participants responded that ventilator circuit must be change weekly. Fifteen point eight percent of the sample responded that positions of the patients did not influence VAP prevention while 67.9% responded that semi-recumbent position was used in ICU setup to prevent the risk of getting VAP (Table 3). A study conducted by Labeau *et al* (2007) noted that 85% of studied participants knew that semi-recumbent positioning prevents VAP. When comparing two studies, this result was not consistent with the present study as high percentage of satisfactory practice was demonstrated by Labeau *et al* (2007) study. It may be due to the heavy workload of Sri Lankan nurses and they may not have adjustable beds like the developed countries.

Sixty nine point nine percent participants changed suction system for each new patient (Table 3). According to the study conducted by Labeau *et al* (2008) found that 46% of the sample recommend and 18% knew that closed suctioning systems must be changed only for each new patient.

Majority of the sample (60.3%) identified that Heat and Moisture Exchange (HME) should change 24 hourly (Table 3). A study conducted by Labeau *et al* (2007) in Belgium found that 38% study participants knew that heat and moisture exchangers were the recommended humidifier type and only 21% knew that these should be changed once a week.

CONCLUSIONS/RECOMMENDATIONS

ICU nurses' knowledge regarding VAP was satisfactory as their knowledge on risk factors for VAP and preventive measures of VAP were in this category. Further, their attitudes regarding prevention of VAP were good possibly because as nurses have a positive attitude towards participating in in-service education programs, and adherence to ICU guidelines. Existing practice of handling ventilated patients among ICU nurses was good as they demonstrated good practice on hand washing, patient positioning, and changing ventilator circuits. Nurses play a key role in preventing VAP as many of the interventions are part of routine nursing care. Implementing in-service educational programs for nurses to enhance knowledge is important in the areas such as causative microorganisms of VAP and preventive measures of VAP. In order to further decrease the incidence of VAP, protocols and monitoring tools must be developed.

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KNOWLEDGE AND PRACTICES AMONG SCHOOL CHILDREN ON DENGUE PREVENTION

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INTRODUCTION

Dengue fever is the most common mosquito borne viral disease in the world (WHO, 2014). Dengue fever has become a major public health problem in Sri Lanka in recent years, with significant impact on children (Epidemiology Unit Sri Lanka, 2010). In the absence of specific treatment for dengue, prevention is the most important measure in combating the disease (Epidemiology Unit Sri Lanka, 2010).

Indonesia recorded the highest number (more than 90,000) of dengue cases in the Asian region (The Diplomat, 2014). During the year 2013, 32,063 dengue cases have been reported to the Epidemiology Unit Sri Lanka from all over the island. Further, the Epidemiology Unit Sri Lanka stated that 48 people died due to the Dengue in the end of second quartile of the year 2013. (Epidemiology Unit Sri Lanka, 2013).

According to Winch *et al.*, (2002) school-based education is an important compliment to community education because of the presumed transfer of knowledge and practice from classrooms to homes where ongoing household activities are required as potential control measures to maintain the environmental cleanliness as a source reduction measure. Therefore knowledge of school children plays a vital role in implementing remedial actions for dengue eradication. Despite such an importance of school children's knowledge for dengue prevention less research attention has been paid by the researchers, to examine school children's knowledge of dengue prevention. Thus, this study was conducted with the main purpose of examining the knowledge and practices of dengue prevention among school children in Sri Lanka.

Furthermore, this study describes the existing knowledge regarding dengue fever among school children, identify the current practices used by school children in their home environment to prevent dengue and identify the perceived barriers and available resources to prevent dengue. Findings of the study will be helpful to make strategies for students to enhance knowledge on dengue prevention in case of knowledge gap present. Further, findings can be utilized for health care personnel and policymakers to eradicate this problem from the community.

METHODOLOGY

Quantitative non experimental descriptive research design was used. The study was conducted at the *D.S. Senanayake College* and *Polwaththe Maha Vidyalaya* from the Ampara District, *Wickramabahu Central College*, Gampola and *Gangasiripura Vidyalaya* from the Kandy District. The sample size was 400. 100 students who are studying in year nine to thirteen from each school were randomly selected for the study. Ethical approval was obtained from the Ethical Review Committee, General Hospital, Ampara.

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Pre-tested validated self-administered questionnaire was used to collect data. First part of the questionnaire focused on participants’ demographic data; second part direct questions to identify the existing knowledge regarding prevention of dengue among school children; third part focused on identifying current practices used by school children in their home environment to prevent dengue. Data was collected from 1st December to 31st December 2013. The response rate was 98%. Data was coded and analyzed by descriptive statistics using SPSS 16.0.

RESULTS AND DISCUSSION

According to the demographic characteristics 62.2% of the participants were male students. Majority of the respondents (67.2%) were ordinary level students. 69.5% students of the sample represented rural areas. With respect to the race, 95.2% students were Sinhala ethnic community.

Table 1: Overall knowledge on prevention of dengue (N=395)

Level of Knowledge	Number (N)	Percentage
Poor (0 – 16)	38	9.6
Average (17 – 32)	216	54.7
Good (33 – 50)	141	35.7
Total	395	100.0

Minimum:07 Maximum:46 Mean: 28.60 Standard Deviation: 8.16

Overall knowledge on prevention of dengue was average (54.7%) (Table 1). Similarly a study conducted by Gunasekara *et al* (2006) found that the overall knowledge among urban sub community was average. This may be due to better awareness on dengue prevention generated by mass media where people are mostly exposed so that children could absorb that knowledge.

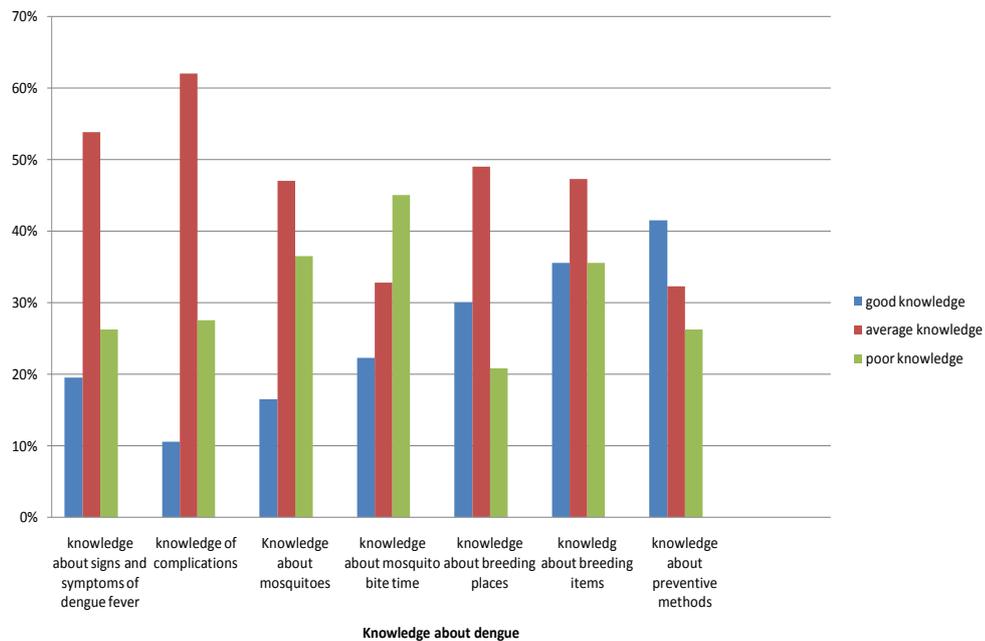


Figure 1: Students’ knowledge regarding dengue

Only 47.2% of the sample identified *Aedes aegypti* as the common vector for Dengue. Further 57.2% of the sample identified morning 7 am to 10 am as the common bite time of this mosquito (Figure 1). A study conducted in Thailand by Koenraad *et al* (2006) revealed that more than 90% of the interviewed females knew that dengue was transmitted via *Aedes* mosquitoes. Surprisingly, a moderate number of respondents in that study was unaware that dengue mosquitoes are more likely to bite in the afternoon. This study results were not consistent with the present study. This might be due to the fact that students might be aware of the bite time of dengue mosquito as prevalence of dengue is high in Sri Lanka.

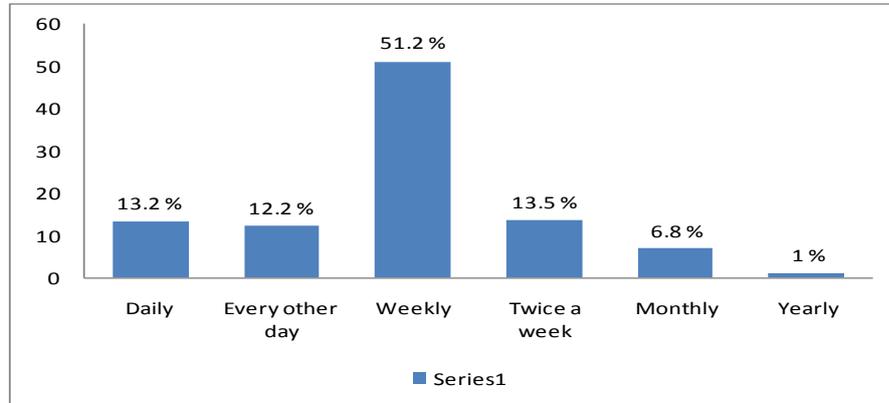


Figure 2: Frequency of checking mosquito breeding places in the home environment

The current practices used by school children in their home environment to prevent dengue were satisfactory in this study. Majority (51.2%) of the sample check the mosquito breeding places in their home environment weekly (Figure 2). A study conducted by Gunasekara *et al* (2006) found that practices among a sub urban community was not satisfactory. This result is not consistent with the present study. This might be due to the fact that school students having an inherent intention of preventing dengue compared to adults. In this study, researchers have identified the most common measures of removing mosquito breeding places were destroying discarded cans and old water filled tyres. However, most of respondents were unaware that ant wrappers provide good place for mosquitoes to breed. The Indian study conducted by Sharma *et al* (2012), identified that majority (66.2%) of the respondents knew that roof gutter as most common mosquito breeding place and of the necessary to clean stagnant water collections. Lack of time was the major reasons for not checking the home environment according to the present study.

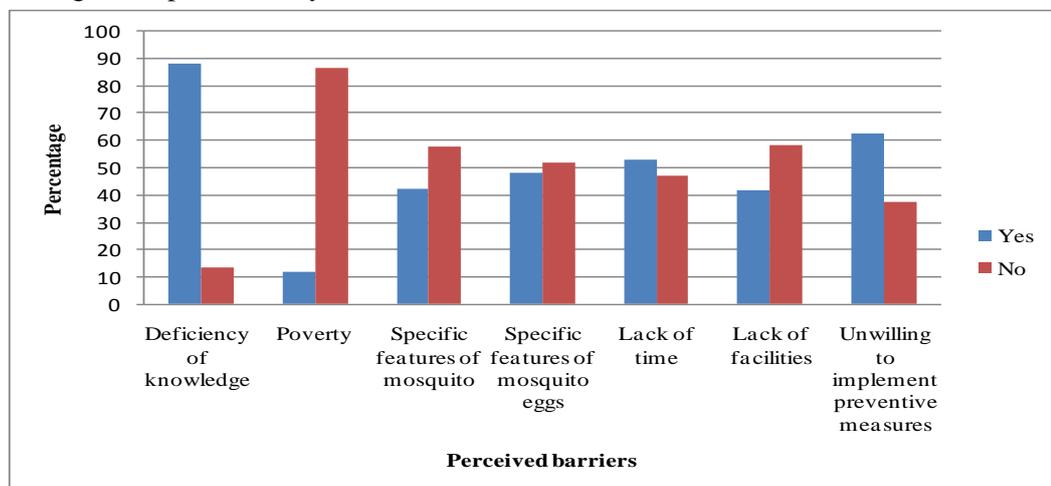


Figure 3: Perceived barriers to prevent dengue

The majority of the sample identified knowledge deficiency regarding dengue (88.5%) and unwillingness to implement preventive measures (62.8%) as major barriers to prevent dengue (Figure 3).

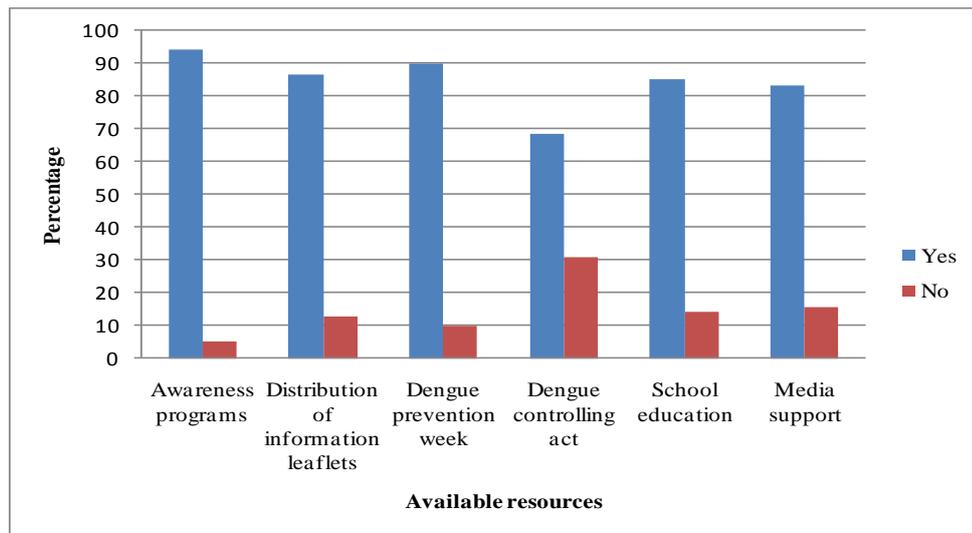


Figure 4: Available resources to prevent dengue

This study revealed that awareness programs on dengue prevention (94.5%), dengue prevention weeks declared by the government (90.0%) and school education on dengue prevention (85.2%) as the major motivators in preventing dengue (Figure 4).

CONCLUSIONS/RECOMMENDATIONS

The participants demonstrated deficiencies in knowledge, and the majority of school children were in the average knowledge category. However, current practices used by school children in their home environment to prevent dengue were satisfactory. Although sound knowledge on dengue prevention is important to control the disease, their practices on prevention of dengue was satisfactory. Knowledge deficiency regarding dengue and unwillingness to implement preventive measures were the major barriers to prevent dengue. Awareness programs on dengue prevention, dengue prevention weeks declared by the government were the main motivators to prevent dengue.

This study is limited to four schools in Sri Lanka due to lack of time. Therefore, it is necessary to conduct more studies in other schools to identify the knowledge and practice variations among school children. Further, this study results recommend to implement urgent strategies to enhance knowledge on prevention of dengue among school children.

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TRENDS AND ISSUES BETWEEN FAMILY, KINSHIP AND THE CASTE SYSTEM IN MODERN SINHALESE SOCIETY

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INTRODUCTION

The formation of the social structure of some human societies depended on the interdependence between caste, family organization, and family relationships. These relationships had a strong influence on the successful operation of the mutual bonds in the society. All societies are organized around the kinship system, varying by how many marriage patterns are allowed, who can marry whom, how descent is determined, family residence, and the power relations within the family (Anderson, Tylor & Logio 2009). In practically every aspect of family life, caste integrity is supported and it is in reference to the home and family that caste strictures and symbols that is most clearly evident. Caste structure is intimately related to the kinship system amongst most human societies. Caste is basically a closed system of stratification, since members are recruited on the criteria of ascribed states (Rayan 1953).

The system of kinship and family organization in Sri Lanka plays an important role in maintaining group cohesion and solidarity and in orienting the individual members to the social maze (Smith 1968). Therefore, as Rayan, Leach, Yalman, who have studied the Sri Lankan society, pointed out, the caste system, kinship and marriage affairs are organized around Sinhalese social organization. This factor is amply borne out by anthropological research undertaken in this sphere about sixty years ago by anthropologists such as Brice Rayan, in a village called Pelpola in Kalutara (Rayan 1953). However, currently the caste system is an elaborate, as well as a complex, social system in Sri Lanka. Sinhalese family structure and community structure are closely interwoven. If terms such as household, family, kin and clan are to be understood fully, they have to be set within this wider social context. Further, families today organize their respective individual domestic duties and their links with the wider social environment in a variety of ways (Pieris 1956).

Therefore, the key purpose of this paper was to discuss the issues and new trends between the family, kinship and the caste system in modern Sinhalese social organization.

METHODOLOGY

A qualitative descriptive design was chosen as it enables the understanding of how people make sense of their attitudes and experiences about caste, kinship and family bonds. This study was conducted in Palpola village where anthropological research has been undertaken in this sphere about sixty years ago by anthropologist Brice Rayan. For data collection, this study used semi structured interviews to assess a simple random sample of fifteen families and the interviews were conducted in the participants own language (Sinhala) to allow the participants to express their feelings as much as possible without hesitation. Data was analyzed according to a qualitative thematic analysis. The interviews were recorded on audio files, transcribed verbatim and decontextualized to a text that could be analyzed. Ethical approval to conduct the study was granted from the Faculty of Humanities and Social Sciences at the University of Sri Jayewardenepura.

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RESULTS AND DISCUSSION

Using the generated 09 sub themes and 03 major themes, the following model illustrates the trends and issues between family, kinship and caste system in modern Sinhalese society (Figure 01):

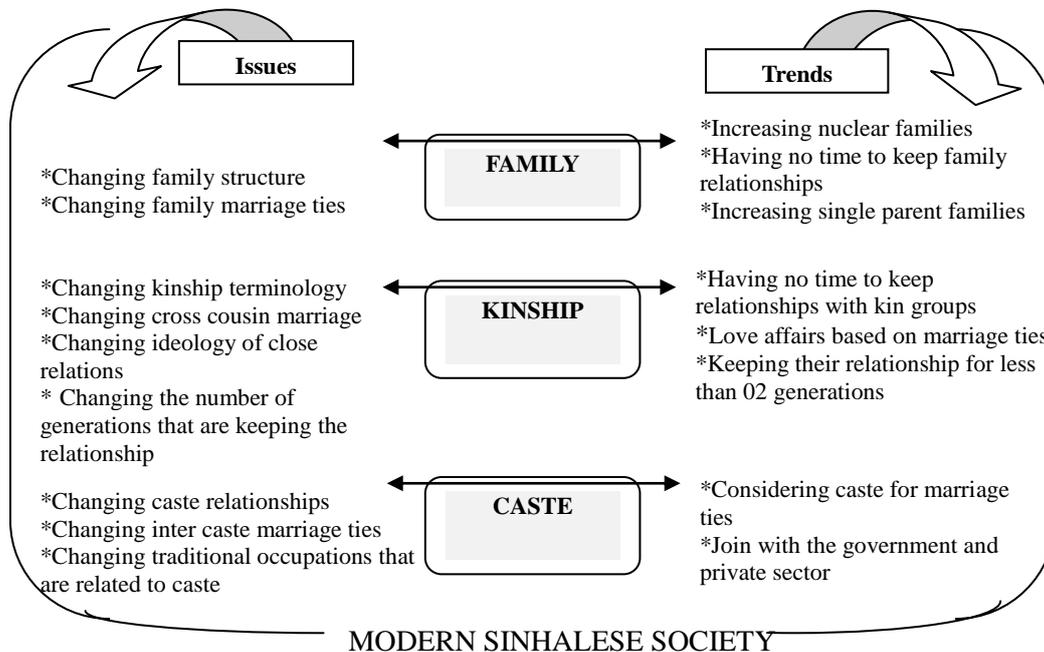


Figure 01: Trends and issues between family, kinship and caste relationships in modern Sinhalese society

The participants, who live in Palpola village, demonstrated various attitudes and experiences related to the family, kinship and caste relationships. These attitudes and experiences can be mainly categorized as follows:

Family structure

According to their family structure, two thirds of the sample could identify the nuclear family that lives with parents and their children.

This was expressed by participant B and F as follows.

“it’s very difficult to live with our relations. I live with our children. My parents live separately. I have no time look after them. This life is very calm...” (Participant B).

“My parents don’t like to live with us. But they come see me. We also go there. They live in my native place. I came here by Diga marriage...” (Participant F and B).

This study also identified broken families.

“I separated from my husband. He had an affair. Now I live with my children” (Participant R and).

When we consider family marriage ties, participants expressed that

“In our fathers’ time, we married only through proposals. Sometimes our elder brothers married as Binna marriage. But our children select their marriage partners through love affairs” (Participant D).

“Today almost all children find their partner through a love affair. We can’t do

anything. What to do?" (Participant A).

When we consider close relations, participants stated different attitudes and ideas.

"My close relations are my children. When I have any problem or difficulties they help me. I don't have any close relations other than them. When I had money my relations stayed with me. But now I don't know whether they are living..." (Participant J and C).

"I consider my neighbors as my close relations. I share my sadness and happiness with my neighbors" (Participant R).

"My close relations are my parents. They give me any support for any of my work" (Participant F and R).

According to their relationship within kin groups, two-thirds of the sample have kept their relationship for 02 generations.

"I am keeping my relationship with my children and my parents' generation. My relations don't keep relationship with us" (Participants K and E).

However, the Sinhalese claim that a seven-generation pedigree in traditional Sinhalese society is necessary to establish the purity of ones' lineage (Pieris 1956). However, today the traditional seven-generation pedigree has disappeared and people set their relationship over approximately two generations (Pieris 1956).

Kinship

To examine their knowledge of kinship terminology, the questionnaire asked about the terminology participants used for their spouse's paternal and maternal brother. Two-thirds of the sample call their spouse's paternal brother as "Mahappa" or "Baappa" and their spouse's maternal brother as "Maama". The correct terminology for the spouse's paternal brother is "Maama" and the maternal brother is "Bappa".

Regarding cross-cousin marriage, participants demonstrated various attitudes and experiences.

"I like cross-cousin marriage very much. We know our relations' ins and outs. So it is not a matter. Our wealth and properties are kept intact" (Participant I).

In traditional Sinhalese society, the most appropriate marriage partner was supposed to be a cross-cousin (Pieris 1956). Today it is undergoing an exit from Sinhalese society.

Two-thirds of sample stated that they dislike cross-cousin marriage.

"We like to select marriage partners for my sons out of kin. Cross-cousin marriage is not suitable. My elder brother married a cross-cousin. He has an abnormal baby. I heard that it is not a suitable thing. We are unable to find new relations and it can transmit various genetic diseases also." (Participant F).

When considering keeping relationships with kin groups, participants stated their experiences and ideas as follows:

"Both myself and my wife work in the private sector. We have no free time to visit our relations. They are also the same. We meet only on special occasions. When we have free time we spend our time at home" (participant G).

"My children work in Colombo. They visit me once a month. I have two brothers and two sisters. But they don't come to visit me. All of our cousins are jealous about us. I'm not in good terms with them" (Participant I).

In traditional society, relationships occupy a very unique position in the Sinhalese society. The generations of relations was an important function in the village. It was the generations of relations who extended aid to the family (Rayan 1953).

Caste relationship

Considering relationships with their villagers, half of the sample disliked keeping company with their neighbors.

“We don’t go to keep company with our neighbors. Some of them are not of our caste. When they come to our house, we give them a lower chair. It has been a ritual since our parents’ time” (Participant K).

Considering relationships with caste and marriage ties, participants state that

“We are very careful about our marriage ties. We don’t like to marry a lower caste partner. It is not a suitable thing for our family rules. We always find his or her rank and ancestry history....” (Participant M).

The regulation of caste was most evident and, beside caste endogamy, even ranks within a caste sometimes refrained from marrying into an inferior family of the same caste in traditional Sinhalese society (Pieris 1956).

When considering their traditional occupations, the participants state that villagers have given up the traditional occupations that were related to caste.

“Our neighbors, who were low-caste people, don’t like their traditional occupations. Now they have joined the government and private sector. Some of them are changing their surname also...” (Participant Q).

The remarkable thing of the Sinhalese is that from an individual’s family name, called the “Vasagama”, it was possible to identify his societal rank and ancestry history (Rayan 1953). However, when they change their surname, it is very difficult to make such identifications.

CONCLUSIONS/RECOMMENDATIONS

The findings of the study demonstrated changes among caste, kinship and family bonds. Like other social institutions, the family is in a constant state of change. The increasing global basis of the economy means that people often work long distances from other family members, as well as kin groups. Working parents may have less time for each other during the week, too. Relationships are placed more under stress, family members do not feel as close and as involved with one another, and family living can become less enjoyable. It causes broken families. The villagers have no time to maintain relationships with each other. When family members have no time to maintain relationships with their kin groups, their knowledge about kinship terminology becomes poor.

The caste system has undergone adaptive changes. Inter caste marriage has almost exited from rural areas. However, the caste structure is intimately related to the kinship system amongst the Sinhalese. Persons who are almost wholly emancipated from caste concepts and who repudiate any form of discriminatory treatment, marry and insist that their children marry within the caste. Family and kinship are, of course, closely related to the discussion of caste and family membership, and marriage alliances rouse as much interest as caste affiliation. Most people are very careful about caste in marriage ties. In recent times, caste has become an important factor in marriage ties only.

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A STUDY ON THE KNOWLEDGE AND PRACTICES OF MOTHERS IN THERMOREGULATION OF NEONATES

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INTRODUCTION

Thermoregulation is the process that allows the human body to maintain its core internal temperature. Humans are capable of maintaining body temperature at a relatively constant level despite changes in the external environment (Paul & Bagga, 2013). Thermoregulation in neonates is one of the biological adjustments taken place at birth, which is a transitional period of neonate (Dutta, 2008) due to poor heat regulating mechanisms. During intrauterine life, the fetal temperature is 5^oC higher than the maternal temperature to metabolic reaction. After birth, the infant is exposed to outside environment which has lower temperature (Paul & Bagga, 2013). Unsatisfactory thermoregulation can cause hypothermia or hyperthermia of neonates. As World Health Organization (WHO) has defined, maintaining axillary temperature of 36.5^oC to 37.5^oC is normal in neonates and the temperature below 36^oC is known as hypothermia. Furthermore, there are stages of hypothermia: cold stress is 36^oC to 36.4^oC, moderate hypothermia is 32^oC to 35.9^oC and severe hypothermia less than 32^oC. Hyperthermia is defined as a temperature greater than 37.5–38.3 °C that occurs without a change in the body's temperature *set-point* (WHO).

Although, hyperthermia is the major contributor for neonatal killing, hypothermia is also considered as the silent killer of the new born (Dutta, 2008). Out of approximately 125 million infants born every year, about 2.5% newborns die due to hypothermia (WHO, 2014). Therefore, prevention and management of hypothermia and hyperthermia are one of the key interventions for reducing neonatal mortality and morbidity. That is a major responsibility of health care providers. Mother is the key role in protecting her neonate. Therefore, she has a responsibility and a right regarding safety and security of the neonate. Hence, mothers' knowledge and practices on thermoregulation plays major role in neonatal care. She should have a thorough knowledge related to thermoregulation of her neonates. Several studies were conducted to find out the knowledge of mother related to thermoregulation in the world (Padiyath et al, 2010; Bandari et al, 2010; Varma et al, 2010; McCall et al , 2010). However, there were no studies conducted related to this topic in Sri Lanka. Thus, this study was designed to examine the mothers' knowledge and practices of thermoregulation of neonates in Sri Lanka giving special attention to hypothermia since hypothermia is a major cause (3 %) for neonatal death in Sri Lanka (personal communication, neonatologist, Teaching hospital, Kegalle). The researchers expected to achieve the following objectives from this research: identifying mothers' existing knowledge regarding thermoregulation of neonates and identifying current practices of mothers in thermoregulation of neonates. Among the practices of preventing thermoregulation, kangaroo care was given more attention since it is considered as the most effective method of prevention of thermoregulation (Baswanthappa, 2007)

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METHODOLOGY

The quantitative, descriptive research approach was utilized in this study. Target group was post natal mothers of the postnatal wards at North Central Teaching Hospital Ragama and Teaching Hospital Kegalle. The study sample (n=150) was collected from just before the discharging of post natal mothers during the one month of period by using convenient sampling technique. To achieve the objectives close ended questionnaire was used which consisted of 41 questions to cover the areas of demographic data, knowledge related to thermoregulation, and practices for prevention of hypothermia. Ethical approval was granted from South Colombo Teaching Hospital. Data was analyzed by descriptive statistical analyzing method using SPSS 17.

RESULT AND DISCUSSION

Response rate of the sample was 97.3 % (n =146) . The study sample contained 63% (n=95) of hypothermic babies while others were normal babies. This proved that hypothermia is a burden issue in Sri Lanka delineating that half of the mothers in the sample had hypothermic babies ($Z = 1.28, < Z_{\alpha}$ as $1.5 < 1.96, Z_{\alpha}$ at $\alpha = 0.05$ is 1.96). This finding were similar to the study of Darmstadt (2007). This proved that despite of cultural, educational, occupational barriers hyperthermic level of neonates in Sri Lanka is the same as the other third world countries.

Figure 01 a and b shows that mode of the delivery ($\chi^2=2.26 < \chi^2_{0.05,3} =7.81$) and the birth weight ($\chi^2=4.54 > \chi^2_{0.05,3} =7.81$) were not affected significantly in the thermoregulation of the babies in the study.

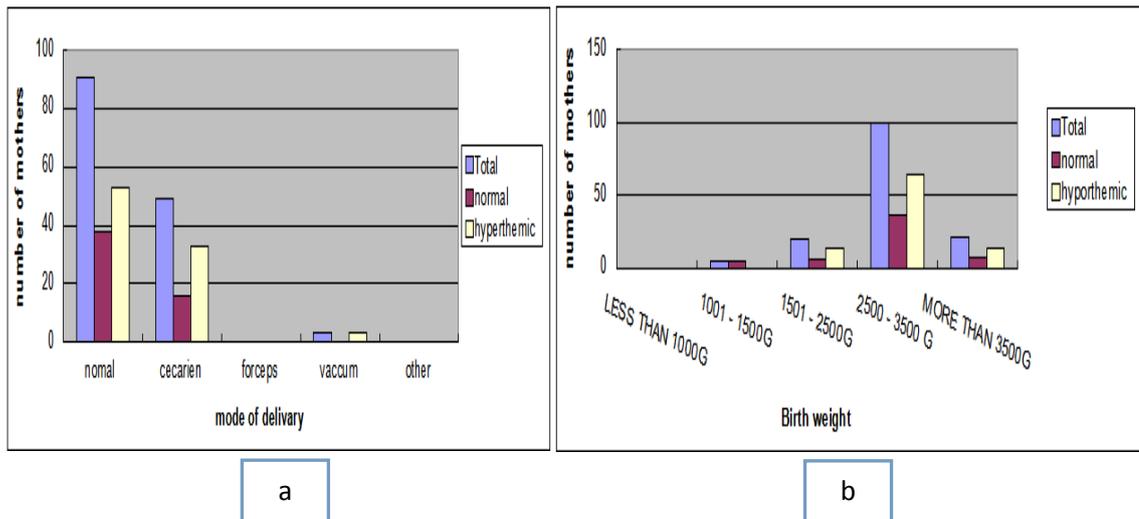


Figure 01 a) - Effect of mode of delivery on hypothermia b)-Effect of birth weight of babies on hypothermia

There were no significant difference in knowledge of mothers having normal babies and hypothermic babies. The data was analyzed to find out whether they have sufficient knowledge of thermoregulation under following topics: 1- causes for falling body temperature of neonates, 2- signs of hypothermia, 3- problems due to hypothermia, 4- kangaroo care, 5- bathing techniques. Knowledge related to thermoregulation of mother was not a significant factor ($\chi^2=3.32 > \chi^2_{0.05,3} =7.81$) for the hypothermia of the babies (Figure 03) which is totally different from the previous studies (Bhandari et al, 2010).

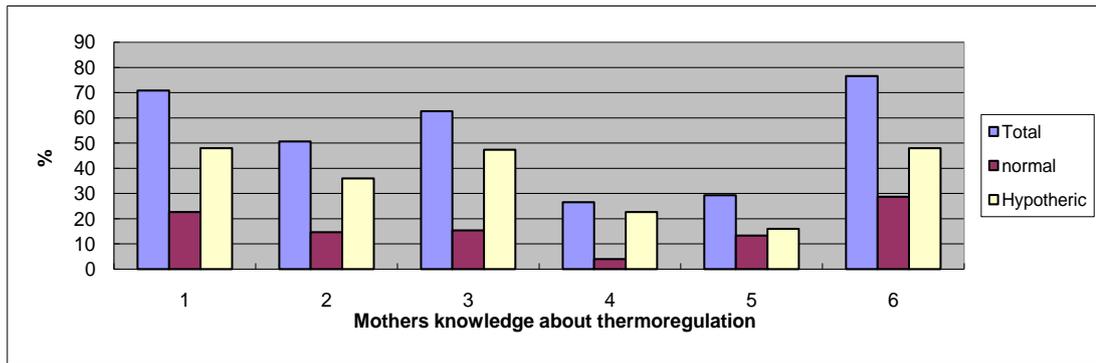


Figure 03: Mothers's Knowledge related to thermoregulation of babies

Figure 04 illustrates the gap between knowledge and the practices of the mothers related to thermoregulation. This compares the mothers' knowledge and practices and how they affect the thermoregulation of neonates under following topics: 1- maintaining neonatal body temperature, 2- preventive action of hypothermia, 3- preventive actions of hyperthermia, 4- Kangaroo care, 5- bathing techniques. According to the findings of this study, the mothers' practices were not reflected in their knowledge related to thermoregulation of neonates. That mean in Sri Lanka, hypothermic situation of the babies is not due to poor knowledge of thermoregulation like other countries (Mullany et al, 2008). However, the difference between knowledge and practice of kangaroo care was vice versa when compared to other categories. This may be due to the traditional concepts prevalent in Sri Lanka. In Sri Lanka, as a tradition, separate cradles or beds are not used for neonates and mothers always keep their babies with them for skin to skin contact. This is the reason for higher practicing rate of the kangaroo care although mothers do not know it, this is a novel technique of protecting body temperature of neonates.

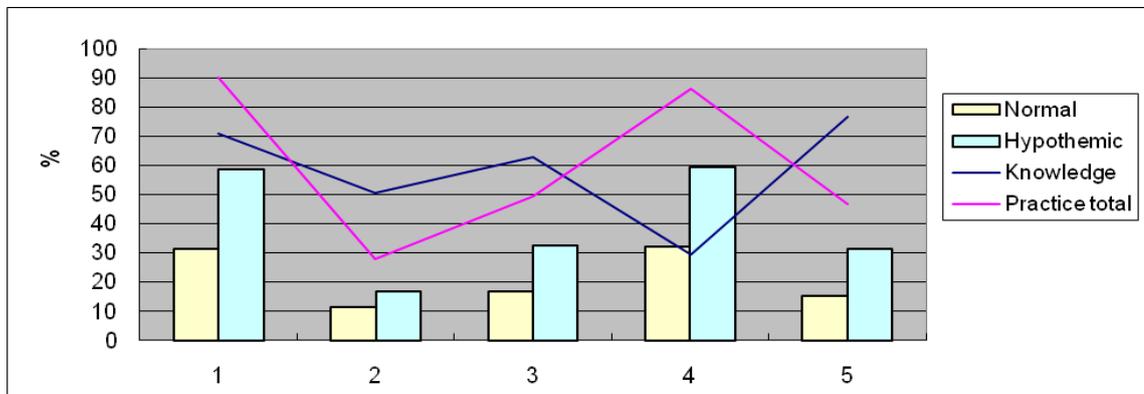


Figure 04- Comparison of knowledge and practices of mothers related to the thermoregulation of babies

CONCLUSION AND RECOMMENDATION

This study investigated the post natal mothers' knowledge and practices regarding thermoregulation of neonates. Although the results showed that most of the mothers had adequate knowledge regarding thermoregulation in neonates, some mothers did not know the proper method of protecting body temperature of their babies and most of mothers did not practice preventive measures of hypothermia correctly. According to the findings, researchers suggest that maturity of the babies, educational level or socio - economic condition of the mothers, and their myths did not directly influence on neonates' hypothermic conditions. Although, many mothers' knowledge is at a satisfactory level, most of babies were hypothermic.

The following recommendations are made on the basis of the findings of this study. Researchers expect to discuss these research findings with policy planning committee of Family Health Bureau who is the responsible body for neonatal care to implement educational programs for mothers island-wide. In addition, researchers expect to stress the importance of preventing hypothermia to nursing students and midwifery students in the School of Nursing.

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ASSOCIATIONS BETWEEN ULCER CHARACTERISTICS AND DRESSING TYPES ON HEALING OF DIABETIC LEG AND FOOT ULCERS

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INTRODUCTION

Diabetes Mellitus (DM) has become a global public health concern due to its increasing prevalence worldwide. This situation is seen in an escalating rate in Sri Lanka too. Among the complications of DM, foot ulcers create a major socio-economic impact due to its high morbidity and mortality. Owing to the complexity of wound healing, diabetic foot ulcers affect on the quality of life of an individual.

Among the multiple factors which impair healing of diabetic foot ulcers, Peripheral Vascular Disease (PVD), neuropathy and foot deformities play a major role. Presence of healing impairment in diabetic wounds increases the risk of infection, amputations and death. Therefore, it is vital to monitor the progress of wound healing through regular wound assessments. Measuring the dimensions of ulcers and determining healing durations have been identified as key determinants in wound healing. A previous study on diabetic ulcer has observed that median time taken for healing was 78 days (Jeffcoate *et al.*, 2006). An investigation on ulcer site and healing concluded that there was no association between the number of ulcer healed with the site of the ulcer (Ince *et al.*, 2007). Thus ulcer size, duration, and site were reported as factors predicting the healing rate.

When considering the widely used dressings in diabetic wound care, both conventional and more advanced dressings are being used. A preliminary study conducted in a Teaching Hospital in Sri Lanka has observed that Povidone iodine (Betadine) as the mostly used wound dressing material in the outpatient setting (Sriyani *et al.*, 2013). In addition, newer topical creams, ointments, gels and dressings are being used for management of diabetic wounds. Previous studies have shown some evidence to support the use of cadexomer iodine and silver-impregnated dressings (Carter *et al.*, 2010) in improving the short-term healing of wounds. Although honey is supposed to contain antimicrobial activity against broad spectrum bacteria and fungi this was not proven to be beneficial.

Although ulcer measurement is found to be beneficial in monitoring the progress, this is not done widely in the Sri Lankan hospital setting (Kumarasinghe, 2004). Studies on wound measurements and determining wound healing durations do not happen in the local setting. Different centers are using a wide variety of dressing materials without assessing. Therefore, the aim of the study was to determine the healing duration and identify associations between healing and ulcer size, ulcer site and dressings in diabetic leg and foot ulcerations.

METHODOLOGY

This study was carried out as a prospective longitudinal study. Data were collected during the course of routine management. Patients were recruited from two hospitals between November

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2012 and 2014 February. This study was approved by the Ethics review committees of the University of Sri Jayewardenepura and permission to recruit patients were obtained from relevant hospital authorities. Type 2 DM patients whose hemoglobin level more than 7 g/dl, wound size not less than 2.5cm² and duration of ulcer more than one week but not more than 3 months were included to the study. Patients with impalpable pulses of lower limb, critical limb ischemia who require revascularization or leg amputation, patients on osteroids and patients who have and cognitive impairment were excluded from the study.

Data on socio demographic factors and diabetic history recorded by an interviewer administered questionnaire. Data on fasting blood glucose (FBG) and type of materials used for wound dressings were obtained from medical records. Glycosylated hemoglobin (HbA1c) levels were determined on completion of wound healing assessment at 12 weeks. Durations of ulcer from the point of onset of ulcer to initial assessment and from onset of ulcer to complete healing were noted. Healing (complete epithelialization) was confirmed by a physician when appropriate. The site of the ulcer was recorded. Ulcers were photographed and ulcer surface area was measured with PictZar Pro 7.01 software at 4 weekly intervals up to 12 weeks. The results were analyzed by both descriptive and inferential statistical methods using Statistical Package for Social Sciences (SPSS) software (Version 16). Non parametric, Spearman's rank correlation, Kruskal Wallis, and Mann-Whitney U tests were performed. The level of significance was accepted at alpha 0.05.

RESULTS AND DISCUSSION

This study is the only reported study in Sri Lanka investigating healing rates, duration and associations for healing of diabetic leg and foot ulcers. A total of 77 subjects (35 males) with a mean age of 57.66±11.1 years and a mean duration of diabetes of 8.59± 6.9 years were included. Their mean fasting blood glucose (mg/dl) was 123.9± 27.5 and the mean glycosylated hemoglobin (HbA1c) % was 7.5±1.4.

Factors affecting the healing duration of ulcers

Mean surface area of the ulcers at the initial presentation was 14.1±10.4cm². The ulcer surface areas of midfoot and forefoot ulcers were 21.9±7.4cm² and 11.4±7.5 cm² respectively. Median estimated duration of the ulcers from the time of ulcer onset up to first assessment was 15 days (Inter quartile range-IQR= 9) and the median duration of healing was 95 days (IQR=50) (Table 1). A similar study reported that the median healing time as 70 days comprising a median ulcer surface area =1.5cm² (Oyibo et al., 2001). Evidence from two other studies conducted in patients with neuropathic ulcers also reported on shorter healing times (Ince et al., 2007; Zimny & Pfohl, 2005) as 75.9 days (ulcer area=9.69 ±1.31cm²) and 63 days (ulcer area= <1cm²>3cm²) respectively. Although the onset of ulcers in the present study were similar to another study (Ince et al., 2007) longer healing time in this study may be related to the larger ulcer area at the time of presentation.

The most predominant ulcer site was forefoot (61%) followed by midfoot 13%, leg 11.7%, and ankle 7.8% and hind foot 6.5%. Tanzanian study also (Chalya *et al.*, 2011) has reported about the common occurrence of forefoot ulcers (68%) similar to this study. However another study in UK (Oyibo, 2001) has shown a greater ulcer incidence on forefoot (79%). High occurrence of forefoot ulcers may be attributed to neuropathy and ischemia resulting ulcer formation at extremities of toes, between toes and metatarsal heads. Comparatively to ulcers in other sites, higher median durations for healing (in days) were seen with forefoot (101.5, IQR=36) and midfoot (95.5, IQR=41) (Table 1). This might be an added reason for the increasing healing durations. In contrast, a study in USA (Birke, 2002) has observed rather a lesser healing duration for forefoot ulcers. Perhaps this variation may be related to smaller ulcer surface area and better treatment options available for patients in their setting. Despite the size of the ulcer, prolong healing durations expend a greater wound care cost. Hence, steps should be taken to reduce the healing durations of these patients.

The ulcer surface area at the time of first assessment and the overall healing time were positively correlated ($r=310$, $p=0.031$). This observation was agreeable to findings of previous study in UK (Ince *et al.*, 2007). This confirms that larger size of the ulcer at the initial assessment requires a longer time to heal. Thus, patients should be educated on early admission for treatment. Statistically significant difference was seen between ulcer surface areas of different ulcer sites χ^2 (4, $n=77$) = 10.749, $p=0.030$. Midfoot ulcers covered a larger area compared to other ulcer sites (Table 2). However, no significant association was found between ulcer site and overall time taken for healing ($p=0.130$). In agreeable to our findings, Oyibo *et al.* (2001) and Ince *et al.* (2007) also did not report any association between ulcer site and duration of healing.

Table 1: Healing durations (in days) of ulcers at different sites (n=55)

Ulcer site	Frequency %	Mean±SD	Median	IQR
Forefoot	34 (61.8%)	100.4±31.8	101.5	36
Midfoot	4 (7.3%)	102.5±22.7	95.5	41
Hindfoot	4 (7.3%)	89.5±47.9	83.0	90
Leg	8 (14.5%)	72.0±39.0	63.0	36
Ankle	5 (9.1%)	82.0±31.9	84.0	45

SD - standard deviation

Table 2: Ulcer surface areas (cm²) of ulcers at different sites (n=77)

Ulcer site	Frequency %	Mean±SD
Forefoot	47(61.0%)	12.98±10.2
Midfoot	10(13.0%)	21.98±7.5
Hindfoot	5(6.5%)	13.05±8.6
Leg	9(11.7%)	11.36±12.9
Ankle	6(7.8%)	14.21±7.5

SD - standard deviation

Patients' age ($p=0.959$), sex ($p=0.345$), FBS ($p=.276$) and HbA1c levels ($p=0.120$) were not associated with overall ulcer healing duration. In agreeable to our results, studies in the USA (Margolis *et al.*, 2000) and UK (Oyibo *et al.*, 2001) also did not find any association between patients' age and sex, and ulcer healing time. A previous studies also could (Margolis *et al.*, 2000) not find any association between ulcer healing time and HbA1c level.

Ulcer healing and wound dressing

Various types of dressings were used for management of ulcers. Povidone iodine was used by 36.4% ($n=28$), a combination of povidone iodine and metronidazole gel (metrogel) 35.1% ($n=27$), and 28.6% used other types of dressings ($n=22$). However no significant differences were observed between dressings type and time spent for healing, χ^2 (2, $n=77$) = 4.297, $p=0.117$. Povidone iodine was the most commonly used dressing material and this might be due to its low cost. Although, a previous study has shown inconclusive evidences for using povidone-iodine solution for managing wounds, an Indian study has confirmed that efficacy of wound healing of calcium alginate and povidone iodine was similar (Nalik *et al.*, 2013). However, previous literature does not give evidence based on a particular dressing type in promoting healing (Game *et al.*, 2012; Hinchliffe *et al.*, 2008).

Healing duration was not determined based on the etiology of ulcer; (neuropathic or non-neuropathic) and smaller sample was studied due to financial and time constrains. These were some limitations of this study.

CONCLUSIONS/RECOMMENDATIONS

Present study shows important associations of diabetic leg and foot ulcer healing in local hospital setting. Ulcer size at the time of first assessment was considerably large and average

healing duration was 95 days. Most predominant ulcer site was the forefoot although the area of the ulcer was less compared to other sites. In contrast, midfoot ulcers were the largest and the duration of healing of ulcer was also long. Thus midfoot ulcers should be managed comprehensively. Healing outcome of ulcers was associated with surface area of ulcers at first assessment. Healing outcomes were not dependent on patient's age, sex, ulcer site, FBS and HbA1c levels, implying that all ulcer patients should be managed uniformly irrespective of these parameters. Povidone iodine was the most commonly used wound dressing material in diabetic wound management and the type of dressing material had no association with the healing duration.

Findings of this study provide benchmark information for studying characteristics of ulcers. Since the ulcer healing times and ulcer sizes were relatively higher management of diabetic ulcers should be carried out comprehensively irrespective of the patient's age, sex and glycemic control. Midfoot and forefoot ulcers should be closely monitored. Povidone iodine being a cost effective dressing material, can be recommended to be used in local setting.

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INFLUENCING FACTORS FOR CATARACTS IN WESTERN AND SOUTHERN PROVINCES OF SRI LANKA.

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INTRODUCTION

A cataract is the clouding of the lens of the eye which impedes the passage of light and prevents clear vision. Most cataracts are related to ageing (World Health Organization (WHO), 2013). Children may also occasionally be born with cataracts, or cataracts may develop after an injury, inflammation or disease. Risk factors for age-related cataract include diabetes, prolonged exposure to sunlight, tobacco use and alcohol drinking (WHO, 2013). Vision 2020 (2014) reported that out of the 20 million people in Sri Lanka, approximately 150,000 are blind and seventy percent of them are blind with cataracts (Vision 2020).

Although cataracts can be removed surgically and replaced with an artificial intraocular lens to restore sight, many people remain blind from cataracts due to inadequate surgical services and high surgery expenses. Furthermore, with the rapidly ageing population, cataract-induced visual dysfunction and blindness cases tend to increase. Thus, cataracts have become a significant social problem all over the world including Sri Lanka. Therefore, preventing cataracts or delaying their progression to visual disability carries the potential for significant benefits. Thus, identifying modifiable risk factors for cataracts is important and may help to establish preventive measures.

Identification of modifiable risk factors that affects the development of cataracts could have a large economic impact and reduce rates of blindness and visual impairment throughout the world. Therefore, the purpose of this study is to examine influencing factors for cataracts among patients admitted to major hospitals in the Southern and Western provinces in Sri Lanka. Further, the study was guided by specific objectives: to identify socio- economic, environmental and medical factors related to cataracts.

METHODOLOGY

A hospital based case control study was conducted at the National Eye Hospital, Colombo and at the Teaching Hospital, Karapitiya. The sample size was calculated based on reviewed literature. With expected proportion exposed in controls= 0.02, Assumed odds ratio= 4, Confidence level: 95% and power of the study = 0.90 the sample size was estimated to be 306 cases, with an equal number of controls. Cases were selected from patients who were diagnosed with cataracts and awaiting cataract surgeries. Patients with congenital cataracts were excluded from the study. The controls were selected from among patients who were not diagnosed as having cataracts but were attending the hospital for conditions other than cataracts. The response rate was 98.04%.

An interviewer administered questionnaire composed of 27 closed ended questions was used to collect data in the study. The study factors were categorized as socio-economic, environmental and medical. Risk factors were subjected to unconditional regression analysis

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by using “MINITAB 14”. Risk factors which showed a p value <0.05 were considered as causing a significant risk. Ethical approval to conduct the study was granted from the ethical review committee of the National Eye Hospital, Colombo and the Teaching Hospital, Karapitiya.

FINDINGS

The mean age of the study group was 60.07 years. Approximately similar numbers of males and females were included in the study. The highest number of participants had G.C.E. O/L qualifications. A majority of the study group indicated that they worked in fields other than farming, business, manual labor, educational and industrial occupations. The findings of the study include three major categories: Socio- economic, environmental and medical factors, related to cataract formation.

Socio-economic factors related to cataract

The study identified significant association of cataract with 5 socio-economic risk factors: Logistic regression results indicated that use of hearth and firewood for cooking (p=0.000), occupational usage of chemicals (p=0.019), cigarette smoking (p=0.024), consumption of alcohol (p=0.000), family history of cataract (p=0.000) were significant socio economical risk factors for cataract formation (P>0.05). The above findings were strengthened by research done in other countries as well (Poknrel *et al*, 2005 and Berendschot *et al*, 2002).

However, use of weedicide and pesticides during farming activities (p=0.066), frequent watching of television (0.630) and frequent use of computers (p=0.147) did not show significant risk of cataract formation (Table 1).

Table 1. Socio-economic risk factors for cataract

Risk Factor	Level	Case N	Control N	Odds ratio	P Value	95%CI Lower limit	Upper limit																																																																								
Use of weedicides/pesticides in farming	No	265	279	0.59	0.066	0.33	1.04																																																																								
	Yes	34	21					Occupational usage of chemicals	No	249	271	0.56	0.019	0.34	0.91	Yes	48	29	Frequent use of computers	No	255	267	0.70	0.147	0.43	1.13	Yes	45	33	Frequent use of television	No	205	209	0.92	0.630	0.65	1.30	Yes	93	87	Cigarette smoking	No	231	252	0.62	0.024	0.41	0.94	Yes	68	46	Consumption of alcohol	No	225	271	0.35	0.000	0.22	0.56	Yes	69	29	Using hearth & firewood	No	156	218	0.42	0.000	0.30	0.60	Yes	135	80	Family history	No	204	263	0.32	0.000
Occupational usage of chemicals	No	249	271	0.56	0.019	0.34	0.91																																																																								
	Yes	48	29					Frequent use of computers	No	255	267	0.70	0.147	0.43	1.13	Yes	45	33	Frequent use of television	No	205	209	0.92	0.630	0.65	1.30	Yes	93	87	Cigarette smoking	No	231	252	0.62	0.024	0.41	0.94	Yes	68	46	Consumption of alcohol	No	225	271	0.35	0.000	0.22	0.56	Yes	69	29	Using hearth & firewood	No	156	218	0.42	0.000	0.30	0.60	Yes	135	80	Family history	No	204	263	0.32	0.000	0.20	0.51	Yes	75	31						
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Environmental factors related to cataract

Among the environmental factors that investigated exposure to high heat ($p=0.000$), accidental contamination of chemicals including lime ($p= 0.011$), exposure to sunlight 6-10 hours a day within the last 20 years ($p=0.000$) were identified as significant risk factors for cataract formation. Wearing sunglasses ($p=0.238$), exposure to electric shock ($p=0.861$) did not show significant association with cataract (Table 2).

Table 2. Environmental risk factors for cataract

Risk Factor	Level	Case N	Control N	Odds ratio	P Value	95% CI	
						Lower limit	Upper limit
Exposure to high heat	No	230	276	0.31	0.000	0.19	0.52
	Yes	61	23				
Wearing sun glasses	No	263	280	0.70	0.238	0.38	1.27
	Yes	27	20				
Chemical accidents	No	272	279	4.14	0.011	1.38	12.47
	Yes	4	17				
Sunlight	No	115	144	0.42	0.000	0.29	0.60
	Yes	116	69				
Exposure electrical shock	No	266	287	0.93	0.861	0.40	2.17
	Yes	11	11				

Medical conditions related to cataract

Logistic regression analysis results indicated that high blood pressure ($p= 0.022$), depression ($p=0.028$), eye diseases ($p=0.049$), near sighted vision ($p=0.000$), long term use of western drugs ($p=0.000$), long term use of ayurvedic drugs (0.040) and exposure to radiation ($p=0.000$) as significant risk factors for cataract formation (Table 3). Similar findings were reported in several studies (Ughade *et al*, 1998; Sperdato *et al* 2001).

Table 3. Medical conditions related to cataract

Risk Factor	Level	Case N	Control N	Odds ratio	P Value	95% CI	
						Lower limit	Upper limit
Diabetes	No	246	258	0.77	0.243	0.49	1.20
	Yes	51	41				
Arthritis	No	253	272	0.64	0.097	0.38	
	Yes	39	27				
High blood pressure	No	239	264	0.58	0.022	0.36	0.92
	Yes	53	34				
Depression	No	270	289	0.42	0.028	0.20	0.91
	Yes	22	10				
Eye injury	No	272	275	0.74	0.396	0.37	1.48
	Yes	20	15				
Eye diseases	No	245	257	0.62	0.049	0.38	1.00
	Yes	48	31				
Use of inhalers	No	241	261	0.95	0.853	0.57	1.60
	Yes	32	33				
Long term usage of western drugs	No	184	243	0.48	0.000	0.32	0.70
	Yes	89	56				
Long term usage of ayurvedic drugs	No	232	258	0.63	0.040	0.40	0.98
	Yes	56	39				
Radiation	No	291	297	0.999	0.000		
	Yes	0	1				
Near sighted vision	No	192	250	0.40	0.000	0.27	0.60
	Yes	93	49				

Diabetes mellitus, arthritis, injuries caused to the eye, use of inhalers did not show a significant risk for cataract formation (Table 3). The study conducted by Sperduto *et al* (2001) confirmed the finding that arthritis is not a risk factor for cataract.

CONCLUSIONS/ RECOMMENDATIONS

In conclusion, use of hearth and fire wood for cooking, the occupational usage of chemicals, cigarette smoking, consumption of alcohol, family history of cataract were significant socio economical risk factors for cataract. Furthermore, exposure to high heat, accidental contamination of chemicals including lime, exposure to sunlight 6-10 hours a day within the last 20 years were identified as environmental risk factors for cataract formation. Hypertension, depression, eye diseases, near sighted vision, long term use of western drugs and long term use of ayurvedic drugs, exposure to radiation were shown to be significant risk factors for cataract formation. The regression analysis suggests that a considerable proportion of cataract cases in these areas are explained by well-established risk factors.

It is recommended to minimize the use of hearth and firewood for cooking, reduce alcohol consumption, and get treatments for near sighted vision defects. Minimizing the occupational exposure to chemicals and the long term usage of western and ayurvedic drugs is also very important in preventing cataract. Furthermore it is necessary to organize awareness programmes to prevent cataract related morbidity including blindness.

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**ATTITUDES AND MOTIVATION OF ENGLISH AS A SECOND LANGUAGE
LEARNERS WITH PARTICULAR REFERENCE TO UNDERGRADUATES OF THE
SABARAGAMUWA UNIVERSITY OF SRI LANKA AND THE UVA WELLISSA
UNIVERSITY OF SRI LANKA**

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INTRODUCTION

It is a remarkable fact that English language has become an inevitable key for success in the modern world. It is considered as a world language mainly because the world's knowledge is enshrined in English. However, today the significance of learning English is highly emphasized in Sri Lanka and the government proposes and implements new programs to improve English language skills of the students almost every year. Thus, most Sri Lankan universities have also acknowledged the need to offer an English course for the undergraduates irrespective of their degree programmes. English Language Teaching Units (ELTU) were established in almost all the universities to facilitate the three or six months intensive English course which commence right at the beginning of the students' university career. However, most Sri Lankan undergraduates are constantly disparaged for their deficiency in English despite having learnt it for many years. The informal talks with the administrators, lecturers and instructors at the universities reveal that students' attitudes and the motivation should be questioned. Attitudes, among various other factors, play a major role in the process of second language (L2) learning. Attitudes are "the individual's reaction to anything associated with the immediate context in which the language is taught" (Masgoret and Gardner, 2003). According to Baker and Jones (1998), if someone has a positive attitude towards learning a L2, they may well succeed in becoming proficient in that language and also at the end of language learning; a desired outcome may be there for students who have positive attitudes towards the L2. Not only positive attitudes, all lecturers and instructors believe that motivation is also essential to decrease high failure and absenteeism rates. Their beliefs are in line with what Dörnyei (2005, 65) puts forth that motivation "provides the primary impetus to initiate L2 learning and later the driving force to sustain the long and often tedious learning process". He also underlines that even if a learner has the best abilities, he cannot attain long term goals without an adequate amount of motivation. He further supports his claim that neither suitable curricula nor good teaching alone is sufficient to guarantee that the individual will succeed. Moreover, it is often reported that the students who are coming from remote rural areas do not obtain upper grades for English as urban students do and most of the failure grades for English are from rural area students.

Having observed this phenomenon, the main objective of the paper is

1. to discover the attitudes and motivation levels of English as second language learners of Sabaragamuwa University of Sri Lanka (SUSL) and Uva Wellissa University of Sri Lanka (UWU) to determine whether the attitudes and motivation could be the reasons for high absenteeism and failure rates of English language courses conducted by these universities.

In addition, the present study attempted to ascertain:

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2. Whether learners' attitudes and motivation differ in terms of the geographical area that they come from.
3. Whether attitudes and motivation differ in terms of the grades they have earned and/or whether attitudes and motivation differ according to their learning environments.

METHODOLOGY

The current study employed a mixed method design which included both quantitative and qualitative research methods. The data consisted of both primary and secondary ones. The primary data were collected by distributing questionnaires to 110 second year students in SUSL and 69 students in UWU and conducting informal interviews in English with both the lecturers and students. It is compulsory for all the students to study English as a second language at these universities as it is in other universities in the country. Statistical test of Kruskal Wallis was employed to analyze data in order to find out whether attitudes and motivation differed according to the learners' geographical area. Crosstabs and Pearson Chi-square were computed to identify any relationship among attitudes, motivation and grades the students obtained for English and the attitudes, motivation and departments they represent.

RESULTS AND DISCUSSION

The study revealed that in both universities learners had diverse attitudes towards learning English and for the most part they were positive. This is quite evident as all the students (100%) in Uva Wellassa University mentioned that they like to learn English very much and nobody mentioned that they disliked it. Similarly, in University of Sabaragamuwa almost 70% students had positive attitudes. This can be reported as a positive sign and it shows the students eagerness to learn English.

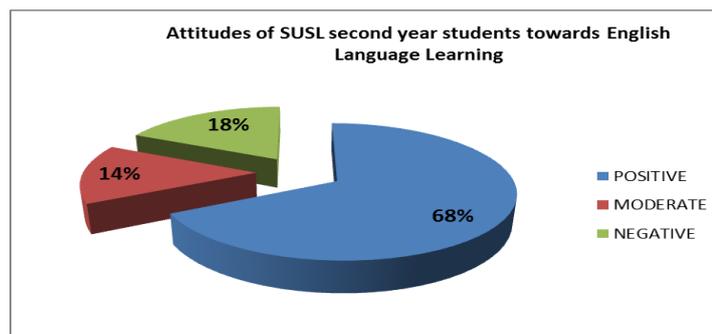


Figure 1: Attitudes of SUSL second year students towards English Language Learning

The statistical test of Kruskal Wallis proved that there is no significant difference of attitudes in terms of the district or geographical area that they are coming from. The test got the result $P > 0.05$ and the P value was 0.116, therefore the null hypothesis is accepted. Accordingly, it is clear that the students' attitudes towards learning English as a second language do not differ according to their geographical area in a significant way.

The Pearson Chi-square was used to identify whether there was any association between students' attitudes with the grades for English or departments they represent. The grades used for the study were the participants' first year 2011-2012 academic-year grades. The table 1 shows that in all the cases the probability is higher than the conventional 5% ($P > 0.05$). Thus the result will not be significant which indicates that there is no relationship between attitudes and grades. The findings on attitudes and departments also revealed that there is no significant difference in attitudes with regard to the departments to which they are attached in.

The study concluded by ascertaining that over 70% of the students possess positive attitudes towards learning English and by discovering that the attitudes do not differ in terms of the students' geographical area, or grades earned, or learning environments.

Table 1: The association between grades and attitudes of SUSL second year students towards learning English

Question	Pearson Chi-Square
1. Studying English is an enjoyable experience.	0.437
2. I really enjoy learning English.	0.356
3. I plan to learn as much English as possible.	0.155
4. I hate English.	0.106
5. I would rather spend my time on subjects other than English.	0.749
6. Learning English is a waste of time.	0.623
7. I think that learning English is dull.	0.373
8. When I leave university, I will give up the study of English entirely because I am not interested in it.	0.830

The study also attempted to demonstrate the motivation levels of the 110 participants in SUSL and 69 participants in UWU. Nearly 12 % SUSL students embodied low level of motivation, approximately 16% students had moderate level of motivation, and about 72% students had high level of motivation. Thus, it can be seen that over 70% SUSL students had high motivation level towards learning English whereas in Uva Wellassa University all the participants (100%) had high motivation towards learning English which can be considered as a positive sign. In addition, according to the classroom observations of the present study it was found that students had a great interest in learning English and it was evident from their class room behavior. For example, they came with their own answers, and ideas along with some questions even without the teacher's request.

Moreover, as far as students' motivation orientations were concerned, the analysis illustrated that most of the students had high levels of instrumental orientation rather than integrative orientation. It is thought that students who are most successful when learning a target language are those who like the people that speak the language, admire the culture and have a desire to become familiar with or even integrate into the society in which the language is used (Falk 1978). According to the results, 64% second year students of SUSL had high level of integrative orientation towards learning English whereas 21% of students had moderate level. Only 15% students had low level of integrative orientation towards learning English. Instrumental orientation is characterized by the desire to obtain something practical or concrete from the study of a second language (Hudson 2000). According to the results obtained, only 10% SUSL students had low level of instrumental orientation while 77% students had high level of instrumental orientation towards learning English. However, about 13% students had moderate level orientation. In comparison, 81.2% of students of UWU were instrumentally motivated whereas 18.8% of the students were intergratively motivated to learn English as their second language.

The Pearson Chi-square was used to identify whether there was any association between students' motivation and the grades for English and students' motivation and the departments they represent. The results revealed that in both cases the probability is higher than the conventional 5% ($P > 0.05$). Thus the correlation coefficient is statistically insignificant which indicates that there is no association between motivation and grades or motivation and the departments.

CONCLUSIONS/RECOMMENDATIONS

The findings of this study may provide insights into the assumption of the lecturers at SUSL and UWU that the students are unsuccessful and there is a high level of absenteeism because they lack positive attitudes and motivation to learn English which turned out to have no scientific basis since the findings of the present research revealed that only nearly 18 per cent of the participants embodied negative attitudes in SUSL and surprisingly 100 percent participants had positive attitudes in UWU whereas nearly 12 per cent of the participants embodied low level of motivation in SUSL and surprisingly 100 percent participants had high level motivation in UWU. Thus, it is clear that in terms of the levels of the attitudes and motivation of the students, UWU is in a higher place than SUSL. However, considerable attention should be paid not only to the students' attitudes and motivation but to the content of the English course, lecturers, teaching methods, the materials used, etc. as well. This might suggest that there is a need for a needs analysis which might help to identify students' needs so that the necessary steps could be taken to remedy the situation including material developers developing materials that can better meet the students' needs and can increase students' attendance in the lectures and success rates in English lessons. Kormos and Csizér (2008) claim that "teachers, materials, and activities are instrumental in shaping attitudes to learning". Since students lose their motivation to learn English and their attitudes towards learning a foreign language formally deteriorate over time (Lamb 2007), for teachers, it is of utmost importance to implement a wide variety of motivational strategies in order to sustain the students' positive attitudes, and motivation, and even increase their motivation level. Therefore, the findings of this study will enlighten the teachers of the fact that SUSL students have positive attitudes towards learning English and possess high level of motivation; however, as teachers, we need to help the students to sustain and develop the motivation.

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HOW STRATEGIC ARE WE? LISTENING TEST EXPERIENCE OF ENGLISH FOR GENERAL ACADEMIC PURPOSES (EGAP) STUDENTS AT OUSL

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INTRODUCTION

Out of the four main language skills, listening plays a major role in an academic setting. When students listen to a lecture, use audio visual material or when they take part in day schools, they need to engage in active listening. An active listener identifies the speech sounds directed towards him, understands the meanings of these sounds, evaluates the message and tries to respond to the message either verbally or non-verbally. According to Flowerdew (1994), “academic listening skills are an essential component of communicative competence in a university setting” (p.7) and the students must develop the ability to listen to a text of considerable length without the opportunity for interaction with the speaker. Macaro, Graham & Vanderplank (2007) point out that there is a considerable body of research carried out on interactional studies and they stress the need to conduct studies on unidirectional listening comprehension.

Research on listening has expanded its scope recently to include learners’ cognitive and metacognitive strategy use prior to and while listening and the researchers have used a wide variety of instruments such as questionnaires, self-reports, diaries, and interviews. Goh (2000), administering a questionnaire to a group of students found that more-skilled listeners showed a higher degree of awareness of their listening problems than that of their less-skilled counterparts. Vandergrift, Goh, Mareshal and Tafaghodtari (2006) designed and validated a metacognitive listening strategy questionnaire and they argue “By increasing their awareness of the listening process, students can learn how to become better listeners, which, ultimately, will enable them to learn/acquire another language more quickly and more efficiently” (p.23).

As discussed above, listening strategy use of learners has been researched to some extent. However, very few studies have focused on learners’ listening test experience and their test taking strategy use. Purpora (1997) studied learners’ test-taking strategy use in general and found that “strategies’ beneficial effects depend both on the type of task in which test takers deploy them and on the combination of other strategies with which test takers use them” (p.315). However, Purpora’s study used only a questionnaire as a data collection instrument and mixed method studies may provide better understanding of students’ test taking strategy use.

The present study, thus, attempts to fill a gap in second language research by using a mixed methods approach to investigate learners’ problems when taking a unidirectional listening test at the OUSL and their test taking strategies during a listening test in English for academic purposes. This is an on-going study and the initial pilot test findings are presented in this abstract.

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RESEARCH QUESTIONS

- 1 .What strategies do students use when taking a listening test in English?
2. What problems do students face when taking a listening test at the OUSL?

METHODOLOGY

The sample consisted of 88 students registered for the EGAP course at the OUSL. Their main academic disciplines were Natural Sciences, Engineering and Nursing and they were in their first year of their undergraduate programme. A questionnaire which asked for their background information and their listening test experience was administered soon after they sat a listening test at the Open University of Sri Lanka. A sub-sample of students were interviewed to identify the problems they face while taking a test in listening and to probe into the strategies they use while listening. The questionnaire used a four point Likert scale from Strongly Agree to Strongly Disagree and it had an open-ended question as well. In addition to these, a sample of students' listening test answer scripts was scrutinized to identify the problems they face when answering listening tests. The types of listening tasks administered were listening to a mini-lecture and listening to a set of instructions. This paper discusses the findings related to listening to a mini-lecture.

RESULTS AND DISCUSSION

Table 1: Descriptive Statistics for Students' Strategy Use

	N	Minimum	Maximum	Mean	Std. Deviation
Cognitive	88	12	42	28.90	5.263
Metacognitive	88	0	15	9.91	2.757

As shown in Table 1, students used both cognitive and metacognitive strategies and their strategy use was found to be moderate. Out of the metacognitive strategies, planning, self-monitoring and self-evaluation strategies were the least used. Selective attention, prediction, note-taking and practicing listening were among the least used cognitive strategies. Guessing meaning from context and utilizing prior knowledge were the most used strategies by EGAP students at listening tests. The interviews with a sub sample of 25 students also showed that most of them are unaware of strategies they can use for effective listening

Table 2: Descriptive Statistics for Students' Perceptions of Listening Tests

	N	Minimum	Maximum	Mean	Std. Deviation
Like Listening Test	88	0	3	2.52	.660
Challenge	88	0	3	2.19	.800

The majority of the sample strongly agreed with the statement "I like to take listening tests in English" and they agreed that it is very challenging.

When interviewed, most of the students said that testing listening was useful and they expressed their concern on the constraints they have to face when taking the listening test at the Open University. Almost all the students interviewed wanted the recording to be played twice and they expressed their willingness to get more practice in listening activities. The students also suggested that the preparation time given before playing the recording should be increased. There were students in the sub-sample who claimed that listening in English was difficult and they were unable to comprehend a listening text in English. Given below are some excerpts from student interviews.

“ I like listening tests. But it is difficult to answer questions after listening to it only once. Please play the recording at least twice.”

“Listening is very difficult. By the time I try to find answers to the first question, the recording is over.”

Students' answer scripts on listening tests were also examined to identify the problems students face when taking a listening test. It was revealed that lack of useful strategies such as selective attention and self-monitoring had affected students' performance at listening tests.

CONCLUSIONS/RECOMMENDATIONS

The present study revealed that the EGAP students' listening strategy use was moderate and most of them lacked the knowledge of both cognitive and metacognitive strategies which are useful in effective listening comprehension. A well-planned strategy instruction may help these students to become more successful listeners. It is recommended that adequate time to be allocated for pre-task preparation at tests and more practice in listening to be provided to these students both online and face to face. This paper presents part findings of an ongoing study which investigates learner strategy use and learner performance according to a number of task and learner variables and the findings of the complete study will be presented at a future forum.

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INVESTIGATING ADVANCED READING STUDENTS' AWARENESS AND APPLICATION OF METACOGNITIVE STRATEGIES IN ACADEMIC READING

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INTRODUCTION

When reading a text for comprehension, essentially the reader requires thinking while going through it. 'Metacognition' refers to the reader's level of thinking that engages active control over the process of thinking utilized in learning situations (Ofodu & Adedipe 2011). Metacognition is a three way process where the reader must develop a plan before reading, monitor his/her understanding of the text, and evaluate his/her thinking after reading (Fogarty, 1994). Thus metacognition helps the learner to know how to use strategies for processing information effectively and enhances awareness along with understanding of the learner's own cognition (Anderson, 2002; Kuhn, 2000). Some teachers believe students in general are aware of metacognitive strategies and are experienced in using them, although most students are unaware of the metacognitive process (Fogarty, 1994).

The Metacognitive Awareness of Reading Strategies Inventory categorizes these strategies into three (Mokhtari & Reichard, 2002). The first category represents the foundation or global strategies such as setting the purpose for reading, activating prior knowledge, predicting what it is all about, using text structure and skimming. The second category, i.e., problem solving strategies, is applied when it is necessary to revamp comprehension failure. Problem solving strategies help learners to decide when and why to apply these strategies and which to apply at a given time. The real and active interaction of the reading is enhanced by the third category: support reading strategies such as taking notes, paraphrasing, asking self-questions, underlying text information, discussing reading with others and summarizing.

The current study examines the advanced reading students' awareness and application of metacognitive strategies in academic related reading. Further, it investigates whether proficiency level also accounts for differences in the students' awareness and application of metacognitive strategies in academic reading.

METHODOLOGY

Forty four students from the Diploma in English and English Language Teaching- Level 3 (1st years of B.A in English and ELT) Programme and 67 students from the Advanced Certificate in English Programm were selected as the sample of this study. The english proficiency level of the Diploma students could be defined as upper intermediate to advanced as there were a few participants who said that their first language was English. The Advanced Certificate students were at intermediate level. Students of these two groups were almost similar demographically except for language proficiency level as both the groups had sat for the same Entry Test and they had been selected to the programme according to the marks obtained. Students from both the programmes follow the same Advanced Reading Skills Course as a core component in their study programme. A questionnaire titled "Students' awareness and application of some strategies in academic reading" was personally administered as the research instrument by the researcher while explaining to the subjects the technical terms where necessary. The questionnaire consisted of three sections. Section A dealt with the profile of the respondents while section B elicited data on participants' awareness of metacognitive strategies in academic reading. Section C obtained responses on students' application of metacognitive strategies in academic reading. Section B consisted of 9 items

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whereas section C contained 6 items with a 2-point (“yes” or “no”) rating scale. The method used by Ofodu and Adedipe (2011) was adapted. The metacognitive strategies selected for the study represented different types of metacognitive reading strategies such as Global Reading Strategies (Skimming, Scanning, Prediction); Problem Solving Strategies (Inference, Monitoring, Visualizing); and Support Reading Strategies (Questioning, Verifying, Summarizing).

The data obtained were scrutinized quantitatively. Frequency counts and percentages were calculated descriptively to measure the students’ awareness and application of metacognitive strategies in academic reading. Furthermore, *Paired Samples t test* was applied as the main technique in the inferential statistics analysis to scrutinize the relationship between the students’ awareness and application of metacognitive strategies in academic reading. The hypotheses formulated for the study were tested utilizing *one way ANOVA descriptives* at 0.05 level of significance.

RESULTS AND DISCUSSION

Question 1: To what extent are advanced reading students aware of metacognitive strategies in academic reading?

Table 1: Descriptive analysis of students’ awareness of metacognitive strategies in academic reading

ITEMS	YES	%	NO	%
Skimming	92	82.88	19	17.12
Scanning	85	76.58	26	23.42
Questioning	91	81.98	20	18.02
Inference	45	40.54	66	59.46
Verifying	81	72.97	30	27.03
Prediction	72	64.86	39	35.14
Monitoring	51	45.95	60	54.05
Summarizing	87	78.38	24	21.62
Visualizing	88	79.28	23	20.72

According to the results revealed in Table 1 it can be predicted that advanced reading students were aware of the majority of the metacognitive strategies in academic reading to a great extent as most of the strategies obtained over 60% affirmation on the awareness. However, they do not show a satisfactory awareness level in problem solving strategies such as Inference and Monitoring.

Question 2: To what extent do advanced reading students apply metacognitive strategies in academic reading?

Table 2: Descriptive analysis of students’ application of metacognitive strategies in academic reading

ITEMS	YES	%	NO	%
Do you get assistance from others while reading about meaning of expressions and difficult words? (SRS)	76	68.47	35	31.53
Do you adjust your reading rate to suit your reading materials? (PSS)	89	80.18	22	19.82
Do you paraphrase text information while you are reading? (SRS)	63	56.76	48	43.24
Do you set purposes for reading all the time? (GRS)	44	39.64	67	60.36
Do you get meaning instantly? (PSS)	55	49.55	56	50.45
Do you remember what you have read? (GRS)	82	73.87	28	25.23

Global Reading Strategies (GRS), Problem Solving Strategies (PSS), Support Reading Strategies (SRS)

According to Table 2, the majority of respondents adjusts their reading rate to suit their reading material and can remember what they have just read. According to these results, it can

be inferred that advanced reading students apply metacognitive strategies in academic reading to a reasonable degree. However, one of the core Global Reading Strategies, i.e., set purposes for reading all the time was only applied by a fewer number of respondents (39.64%).

Question 3: Whether there is a relationship between advanced reading students’ awareness and application of metacognitive strategies in academic reading

In order to answer this question means of the awareness level and the application level were compared. Furthermore, the following hypothesis was also tested using the results of the *Paired Samples t Test*.

H₀: There is no significant relationship between advanced reading students’ awareness and application of metacognitive strategies in academic reading.

According to Table 3, it can be predicted that the advanced reading students’ awareness (77.66) is higher than the application (68.16) of metacognitive strategies. It shows that advanced reading students’ do not apply metacognitive strategies according to their awareness level.

Table 3: Paired Sample Statistics of advanced reading students’ awareness and application of metacognitive strategies in academic reading

	Mean	Std. Deviation	Std. Error Mean
Pair 1 Awareness	77.66	17.59166	7.18177
Pair 1 Application	68.16	17.15129	7.00198

According to the calculation of *Paired Samples t Test*, the *p value* or the significant value of the awareness and application of metacognitive strategies is (.207). Therefore, it can be decided that The null hypothesis (H₀) is not rejected

since the *p value* is .207 > .05 (α). Moreover, this result can be confirmed further by considering the *Paired Sample Correlations* as exhibited in Table 4.

Table 4: Paired Sample Correlation of advanced reading students’ awareness and application of metacognitive strategies in academic reading

	N	Correlation	Sig.
Pair 1 Awareness & Application	6	.572	.235

As depicted in Table 4 a significant correlation cannot be observed between awareness level and the application level as the correlation is (.572). Further, the significant level of the correlation between these two variables is (.235) > .05 (α). Thus, it can be concluded that there is no significant relationship between advanced reading students’ awareness and application of metacognitive strategies in academic reading.

Question 4: Whether proficiency level accounts for differences in the advanced reading students’ awareness of metacognitive strategies in academic reading

The following hypothesis was tested by means of *one way ANOVA descriptive* to investigate whether there is a relationship between proficiency level of the Diploma students and the Advanced Certificate students and their awareness level of metacognitive strategies.

H₀. There is no significant relationship between proficiency level and advanced reading students’ awareness level of metacognitive strategies in academic reading

According to the *ANOVA statistics descriptive*, the significant level of the correlation between

advanced reading students' proficiency levels and awareness levels is $(.081) > .05 (\alpha)$. Thus, the null hypothesis (H_0) cannot be rejected as there is no significant relationship between advanced reading students' proficiency level and awareness of metacognitive strategies.

Question 5: Whether proficiency level accounts for differences in the advanced reading students' application of metacognitive strategies in academic reading

The following hypothesis was tested using the *ANOVA statistics descriptive* to examine the relationship between advanced reading students' proficiency level and application level of metacognitive strategies.

H_0 . There is no significant relationship between proficiency level and advanced reading students' application level of metacognitive strategies in academic reading.

According to the *ANOVA statistics descriptive* the significant level of the correlation between advanced reading students' proficiency levels and application levels $(.031)$ is less than $.05 (\alpha)$. Thus, it can be concluded that the null hypothesis (H_0) can be rejected. It means, a significant correlation can be observed between advanced reading students' proficiency level and their application level of metacognitive strategies in academic reading.

CONCLUSIONS/RECOMMENDATIONS

The results of the study show that the advanced reading students are aware of different types of metacognitive reading strategies such as global, problem solving and support reading strategies, and apply some of these strategies in their academic reading. The outcome agrees with Ofodu and Adedipe (2011) where ESL students were aware of various metacognitive strategies and applied them in their academic reading.

However, statistically the current study predicts that there is no relationship between the awareness and application of metacognitive strategies by the advanced reading students. Thus, the results show that these students do not apply some of the metacognitive strategies in their academic reading although they are aware of them. Especially it is noticed that the majority of these participants do not apply 'set purposes for reading' although it is one of the essential Global Reading Strategies that make a reading text meaningful. Furthermore, it was observed that the few participants (4.5%) who claimed English as their first language were not aware of all the metacognitive strategies and also did not apply all the strategies considered in this study in their academic reading. On the other hand, the finding contradicts Ofodu and Adedipe (2011) where they found a significant relationship between ESL students' awareness and application of metacognitive strategies. In addition to that, the outcome of the current study predicts that application of metacognitive strategies in academic reading increases with the proficiency level even though a comparable improvement of the awareness level is not indicated. Nevertheless, the findings of the study demonstrate the necessity of improvement of knowledge of metacognitive strategies in academic reading as it is more effective when applied strategically by students in their learning. Only then students can decide when and why to apply metacognitive strategies in their reading and especially which strategy to apply at a given time. Thus, it is required to guide advanced reading students to apply metacognitive strategies in their academic reading as these students learn reading not only as a language skill but also as an academic discipline.

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**A CRITICAL APPROACH TO THE DICHOTOMY BETWEEN THE INNER AND
OUTER REALITIES OF THE CHARACTER 'NORA' IN THE PLAY *A DOLL'S
HOUSE* BY HENRIK IBSEN**

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INTRODUCTION

Research Problem: - How does the obscured actual reality of Nora impact on Helmer's fantasy space in revealing her true identity and securing a liberated existence?

The appearance of femininity and masculinity within a conjugal proximity maintains an inconstant equilibrium through their exterior and interior selves. 'Nora', the nucleus of the fantasized individualistic psychical formation of Helmer, functions as the constant irrational organism that beautifies and preserves the fantasizing elements of Helmer's world. The implementation of Nora as a deprived object, which the dominant, 'big' masculine other prefers and desires within the romanticized conjugal frame, reproduces her feminine identity as a nullified yet rainbow- coloured element that exists based on a groundless, fallacious reality. Along with the claustrophobic psychic atmosphere that confines her social validity into a bedecked nothingness, she makes her reality of true essence an oblivion to the other by wearing a mask of pretentiousness that is coloured with elements such as frailty, immaturity, gendered inferiority, dependency and frivolous perceptive assumptions that are socially attributed to femininity. Nora's interior and exterior appearances, which are embedded within her inner and outer realities, remain circumscribed within segregated spheres that are incapable of merging with or overwhelming the other.

While the superficial texture that colours the outer reality of Nora screens her hidden psychical motives, the inner reality that embodies her socially impossible yet individually possible desires and objectives forms two distinct appearances within her mental and physical spheres. Nora, being conscious of her dual identities, maintains a distance between them, creating a barrier through her superficial pretence with the intention of making Helmer unaware of the separated hidden reality.

The deceptive reality within which Helmer builds his playhouse, into which Nora's role is circumscribed as 'a frail dependent little feminine thing', evolves a fantasy whole where Helmer cultivates his dreams, desires, imaginative assumptions and instinctual motives. Piercing through the illusory veil, the secretive inner reality of Nora emerges, exposing her true identity and questioning and causing Helmer's fantasized whole to crumble.

Thus, this study approaches the text to scrutinize how the obscured actual reality of Nora impact on Helmer's fantasy space in revealing her true identity and securing a liberated existence'.

METHODOLOGY

This study focuses on analyzing the text 'A Doll's House' by Henrik Ibsen based on content, discourse and structural analyses. Since the fundamental focus of the study is to scrutinize and analyze the character 'Nora', the content analysis comprises the methods of relational and conceptual analysis to examine the literary text 'A Doll's House'. Thus, the feminist perspectives of Simon de Beauvoir; the text '*The Second Sex*'; the perspectives of Jacques

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Lacan; *the Lacanian object: dialectics of social impossibility, seminar xiii and xiv*; and Slavoj Žižek's *'From Reality to the Real, How the Non- duped Err, The Seven Veils of Fantasy'* are utilized for the analysis.

RESULTS AND DISCUSSION

Through this research paper it could be analyzed the human beings are entrapped within a fantasy whole from which they cannot perceive actual reality. Thus, basically, female figures are located as the objects of desire and the other within the fantasy space created by patriarchy. The female is recognized as the docile, inferior and fragile bodies whose existence is manipulated by masculine demands.

“Women are identified with nature and the realm of the physical; men are identified with the human and the realm of the mental.” (Warren,11).

Nora, within the patriarchy and its embedded demands and notions, is compelled to be the other, the secondary body whose essence and identity of the self become nullified and negated in the face of relentless and prejudiced principles of the social structure.

“In effect, the man finds satisfaction for his demand for love in the relation with the woman in as much as the signifier of the phallus constitutes her as giving in love what she does not have...”(Lacan,321),

Thus, within conjugal affinity, Helmer's mentality is wholly preoccupied with the motive of keeping Nora as the immature pleasure object, a nobody whose survival relies entirely on him, and a vulnerable being whose desires and dreams are projected through him. Thus, the feminine being is considered to be a dependent role on the masculine authority, and thus allowing her true essence to be dissolved and the inferior identity to absorb her existence.

“Now, woman has always been man's dependent, if not his slave; the two sexes have never shared the world in equality. And even today woman is heavily handicapped, though her situation is beginning to change.” (Beauvoir, xlix).

Nora, despite her submission and passive existence within the fantasized life world of Helmer, endeavours to maintain her own self identity. Natural reality results in Helmer being oblivious to her actual reality, which remains screened by her pretentious superficial outer reality.

Thus, through the scrutinization of the feminine figure 'Nora', this study could analyze to what extent the illusory or the outer reality obscures the actual reality of Nora. Her consciousness, which is identified with her absolute self, induces her to expose her true self towards the social other with the intention of enhancing her essential existential validity. Nora, with the strict determination of doing the most sacred duty to one's self, induces herself to become liberated from the dependence on Helmer with whose identification her 'self' is defined and recognized. As a mere “skylark” with “a vain glory”, and “a play thing” that colours herself to impress the other who holds the symbolic fetters around her, Nora is subtracted from the cultured formula that is constituted of variables such as the realms of the mental, rational, masculine, real and authoritative. In this sense, her independent departure and the resolution to find her true self are not viewed as a sincere effort with vitality, but as an undignified deed signaling insensitivity.

“Nora is a carefully studied example of what we have come to know as the hysterical personality-bright, unstable, impulsive, romantic, quite immune from feelings of guilt, and at bottom, not especially feminine” (Valency, 29).

Thus, Nora's revolutionary rejection of her superficial outer reality and the revelation of her

inner actual reality make her the destroyer of the fantasy whole of Helmer's world.

CONCLUSIONS/RECOMMENDATIONS

The play 'A Doll's House' by Henrik Ibsen elaborately fashions the dichotomy between the feminine and masculine perspectives concentrating on the social assumptions and forces that trigger those conflicting relationships. The character 'Nora' whose existence is trapped between the two distinct realities, which evolve into a dual identity within her physical and psychological realms, portrays the inner desire of a feminine being for the enhancement of liberated individual identity.

Thus, this study delves into the segregated inner and outer appearances of Nora in analyzing the secretive identity that exists within her inner reality while her outer reality fashions the fantasized appearance that the egoistic masculine superiority demands. Consequently, through a comprehensive analysis of the text, based on the theoretical approaches mentioned within the methodology, it can be comprehended that the revelation of the true identity, the inner reality of Nora, dissolves the fantasized sphere of Helmer's masculine superiority and, more explicitly, her revolutionary departure from her superficial reality can be interpreted as a crucial step taken towards feminine liberation.

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THE VIEWS OF STUDENTS WHO ARE LEARNING FRENCH ON THE FRENCH LITERATURE UNITS TAUGHT IN THE UNIVERSITY

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INTRODUCTION

Learning and teaching a foreign language is a challenge. If this is multiplied by the literary studies of that specific language we confront another defy. Incorporating literary texts to teach a foreign language has now become a debatable topic, especially among university students who learn languages.

The French section of the Department of Modern Languages at the University of Kelaniya accepts students for French language studies under the prerequisite of a minimum pass at the G.C.E A/L. French students in the first year of the university reads in the areas of grammar, comprehension, and translation. However, in the second year, they commence studying literature under the course title, French Language and Literature: History and texts, which adjoins as a new dimension in their language studies. Having had first-hand experience of this phenomenon, it is evident that the majority of the students are reluctant to study literature, as they score less marks, and their participation rate for the lectures are low. Therefore, this study intends to find out the reasons for these circumstances. In fact, it is a new area that requires special attention in order to continue to be a fruitful teaching-learning process in the French language.

This research provides an insight into the views of the students who are learning French at the university about the literature unit that they are studying at the University of Kelaniya. The researcher is engaged in this research to find out the views of the students and the lecturers about the literature unit. Thus, the statistical data collected could be employed for course evaluation.

METHODOLOGY

In relation to this new course unit that introduces literary studies, the research problem is to ascertain the views of students who study French at the University of Kelaniya on the French literary study unit introduced in the second year.

In order to answer this question, and to ascertain the availability of materials for literary studies and the productivity of the methods used for teaching, and finally to suggest ways to improve the value of literary studies, this study used an inductive research methodology. Quantitative data was collected through a survey and qualitative data was collected through semi structured interviews.

Thus, from a population of sixty students, a sample of students was taken using random and mixed sampling methods. Twenty five [25] second year students and fifteen [15] third year students were chosen for the survey that comprised of a questionnaire that focused on variables such as the preferences of the students about the literary studies, their satisfaction level on the lecture hours, contents, materials and methods, their reading habits and the range of books they read.

Moreover, five [05] second year students, five [05] third year students and three [03] fourth

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year students were selected for semi-structured interviews. In addition, 02 lecturers were directed to follow a semi-structured interview in order to get their views about their experiences in teaching the literature course unit.

RESULTS AND DISCUSSION

According to the data retrieved from the survey conducted among the students, the results are as follows. The raw data was analyzed using Microsoft excel spreadsheets. The students' opinions about the literature unit in the questionnaire reveals that 56% of second year students and 47% of third year students appreciate this introduction of literary studies in the second year. Nevertheless, according to the statistics, it is clear that there is not much of a difference in the opinions of the two different years. Although affirmative responses apparently are found more among the 3rd years, the divergence between affirmative and negative responses is only 7%.

The questionnaire also contains some questions that query the reasons for their opinion. The majority of the second year students state that this unit of literary studies was difficult. When they struggle with the French language, in which they are not already fluent, it is difficult to study the literature of that language. With regard to the opinions of the third year students, we can see that they accept the fact that the literature facilitates the improvement of their language studies although they found it difficult at first. However, both categories of students prefer this literary unit to be introduced in the first year.

The reading habits of the students were also queried through the questionnaire.

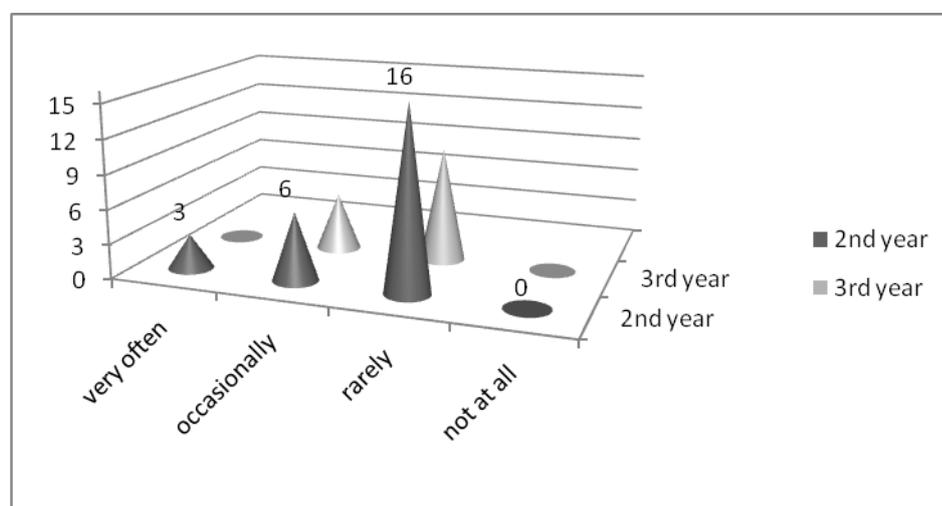


Figure 1: The reading habits of the students

Having studied the table, it is evident that the reading habit, which is a must for the literary studies, is at a low level. According to the data it is evident that 64% of the second year students rarely read. They do not engage in literary work very often, and therefore they find it difficult to learn literature. Especially when learning a foreign language, students must study the language and culture deeply. However, apart from the 24% of students who read occasionally, the majority do not make the benefits of reading.

According to the views of the students, 100% of them are forced to read the recommended literature texts and they probably read them. The majority refers to "*Madame Bovary*" and "*L'amant*" as the books they read. However, sometimes they do not read those books even and do not fully understand the content. The students are asked to mention books they read apart from the recommended texts. Thus, in the second year 60% of students have not answered this question and 66% of the third year students have also left it blank.

The students are questioned on their opinions on the hours, content, materials and methods that were used for literary studies, and the following results were revealed:

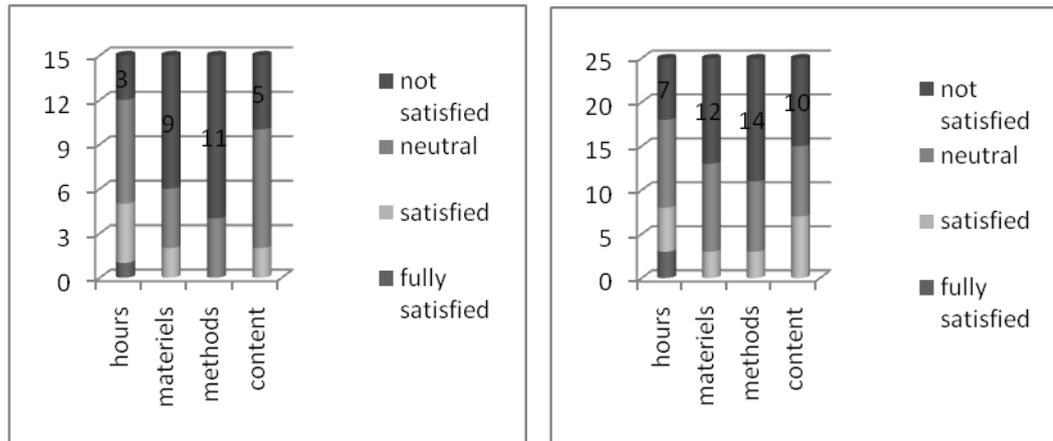


Figure 2: Level of satisfaction- 3rd year and 2nd year

It is obvious that the majority of students have an average satisfaction on this phenomenon. No one has marked the "very satisfied" category. The rate of "satisfaction" is also demonstrated to be at a considerable level when university education is concerned.

It is unfortunate that in the graph of the third year students, none of the students have given their opinion on the satisfaction column. Thus, we can see the negative ideas that prevail among students about the above criteria, which lead to a decrease in their interest in literary studies.

Apart from the questionnaire, according to the information that is retrieved from the lecturers in the semi-directed interviews, they accept their responsibility to make the subject interesting. For most students, literature is a new field. The lecturers admit that the difficulty among students studying this unit is irrevocable as they are studying foreign literature. However, they argue that students also have a role to play in this situation as they are university students and should have the habit of self-studying, to explore further, and not expect lecturers to feed them information.

Furthermore, when the question of resources [teaching materials] was evoked, the lecturers admitted that there is a lack of resources. However, they add about reproach to students for not even using the existing resources, such as the library of the department of modern languages, to improve their reading habits. In addition, students do not attend classes regularly, and so they automatically find the study of literature to be a burden.

Moreover, the lecturers believe that most students who learn French do not have a good knowledge of world literature and also that the students lack experience of real life. Hence, they find it difficult to learn and interpret a literary work as their perspective on the world is still narrow and little.

It is pathetic to see that the lecturers are not satisfied with the writing style of students as there are some primary errors that are sometimes unbearable. Therefore, they prefer if there is a way to refresh the grammatical knowledge of students before the introduction of literary studies.

CONCLUSIONS

Having analyzed the data, the researcher has come to the following conclusions. The majority of students do not like the introduction of literary study unit in the second year. When they are struggling with a foreign language, the obligation to study its literature makes them fatigued. Further, students are not satisfied with the methods and materials used to teach literature. They find it uninteresting to attend lectures where mundane realities are taught in a strange language through literary texts. They expect to be taught using interesting new techniques. Furthermore, students rarely spend their time reading the literary works. They rarely read outside of the program and the internet has become a great source to learn French. Finally, it is evident that their level of understanding of the literary works is at a moderate level.

RECOMMENDATIONS

According to the conclusions retrieved from the data analyzed, the researcher extends a few recommendations in order to provide a better teaching-learning experience to the university, especially among students who are learning the French language. Lecturers can use interesting methods to teach literature, such as through the use of DVDs, Youtube videos, audio clips and pictures in the classroom. They can employ live and interesting examples that are relevant to the literary work during discussions. Having interactive sessions in the classroom, such as group work and role play, without a teacher-centered learning environment can also make the course more interesting to learn. Further, it is apt to provide an opportunity for students to demonstrate their talents and to continually refresh their grammar knowledge with exercises. Providing enough library facilities for students and updating the program with contemporary literature would also be marks of success.

Apart from these recommendations, students also have the responsibility to attend lectures, which are obligatory, regularly. They can utilize the translations of literary works to better comprehend the literary works. They can also make use of the library of the department and recommended websites to learn French. Above all, as university students, they ought to adopt a self-studying and research style to study.

Thus, the results and the recommendations of this research can be used for course evaluation, which could be used to expedite service and enhance literary studies in the French language among university students.

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“THERE ARE NO MEN HERE”: POLITICS OF BEING A ‘MALE’ IN THE MAHAVAMSA

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INTRODUCTION:

“Spare my life, sir, I will give thee a kingdom and do thee a woman’s service and other services as thou wilt.” (Kuveri to Vijaya, Chapter VII, *Mahavamsa*)

“But, in spite of their demand, the prince refused the consecration, unless a maiden of a noble house was consecrated as queen.” (*Mahavamsa*, Chapter VII)

Munasinghe (2004) in her study of the representation of females in Sri Lanka’s past (questionably) titled ‘Sri Lankan Women in Antiquity’¹ refers to the *Mahavamsa* as a story of “the vicissitudes of the Buddhist Order and of the rulers who contributed towards the advancement of that order” (Munasinghe 2004). In that research, she uses extensive information extracted from the two historical chronicles, *Dipavamsa* and *Mahavamsa*, to construct a representative picture of the textual woman.

On the surface, the present research paper is a response to Munasinghe’s work: it explores the construction of the ‘male’ gender in the *Mahavamsa*. However, this researcher would resort to a different set of assumptions and a reading strategy to understand the ‘maleness’ of the *Mahavamsa*. This paper acknowledges the feminist theoretical stance that no gender category is created in isolation: masculinity would be created only in response to femininity. In reading the *Mahavamsa*, this paper politicizes the normative male by re-reading the males of the historical chronicle as a construct against the female and other competing males within the narrative space.

Thus *Mahavamsa* would be re-read as a chronicle about gender power struggles. The gender politics hidden underneath the seemingly glorious patriarchal initiatives of nation building, patriotism, war mongering, consecration and seduction would be located and questioned. The narrative modalities of positioning the feminine gender to protect the male gender in critical situations would be questioned. The apparent omission of females from political spaces, their relegation to harems and their alleged capacity to drive “men mad,”² or in other words to unsettle their unconscious directly, would be questioned and problematized. It is argued that *Mahavamsa*, could be read as a chronicle about what it means to be a male (and therefore, a female!) during a given socio-political-economic milieu in a geographical space that we presently call Sri Lanka. It is a book of omission and commission as far as gender power relations are concerned.

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² Questionable because the research excludes females of other ethnic communities *Mahavamsa*, Chapter IX, pg: 65

LITERATURE SURVEY

Munasinghe's exploration of the female gender through a study of the historical chronicles of Sri Lanka is an invaluable contribution towards gender studies. Primarily, she has demonstrated that historical chronicles are fertile spaces to explore gender politics. Her extensive exploration of the female in the spaces of religion, employment and attitudes of a particular historical period in Sri Lanka presents mixed findings about the representation of women. She surmises that while the woman played an "unpretentious" role within the texts with home as her domain, she exerted pressure on the husband when it came decision making and that she commanded respect of the society for her leading role played in religious rituals (Munasinghe 2004). It is clear from her findings that the female gender, though seemingly marginalized in the narratives of the chronicles, is not so when closely scrutinized.

Chinese masculinity researcher, Louie (2002) carried out an extensive study of the Chinese male in both the classical and contemporary Chinese literature. In his exploration of the classical Chinese literature he discovered two traditional cultural dyads that were used to represent the males, namely *wen* (cultural attainments) and *wu* (martial valor). These dyads, Louie argued, were not consistent in China's past – rather they changed from time to time. At certain periods of time, (as evident from classical literature) *wu* became associated with an elite form of masculinity, while *wen* a non-elite form. In his study Louie also argues that in modern China being a male demanded a perfect balance of both *wen* and *wu* thus privileging such males as those who had attained perfect male identity.

Medawattegedara (2012) in a study focusing on the representation of masculinity in contemporary erotic literature of Sri Lanka surmised that masculinity of elite southern English-speaking males was expressed through sexual prowess and a series of supporting conditions like possession of wealth and mobility. The females in the studied texts did not necessarily valorize this type of masculinity.

The literature survey demonstrates a gap in the masculine studies in Sri Lanka, particularly with reference to classical texts.

METHODOLOGY

This research will entail re-reading the *Mahavamsa* by not taking masculine normativity for granted. It will thus problematise the male gender and attempt to explore how the male gender is created with respect to the female gender keeping in mind that singularity requires a pair for a sense of identity, to not only affirm what one is, but also what one is not. This research will also locate and interpret the 'traditions' of being a male as depicted in the *Mahavamsa*. As suggested by Bronner (2005) "traditions" are "tendencies and continuities through time and space in human knowledge, thought, belief and feeling." This research will also explore *Mahavamsa* for polarities of class since it is primarily a text about kings and queens (who largely belong to one ethnic community). The research will also scrutinize the inter-male power hierarchies.

RESULTS AND DISCUSSION

The males depicted in the *Mahavamsa* are constructed as the centre of a confluence of conditions. A male takes the initiative of creating a nation, but not without the help supernatural forces, females and rare coincidences. If any one of the conditions is removed from the narration, the nation-building initiative would not be complete. The kings of *Mahavamsa* depend on the fulfillment of a plethora of (conflicting?) conditions such as physical prowess, virtue, shrewdness, good luck, a female donor figure, a maiden as the queen and supernatural powers in order to attain their political goals. It is obvious

that the creation of the male in the texts require, among many other conditions, a female donor figure, who usually comes in times of trouble and helps the male selflessly, confidentially and then disappears from the narration. The 'maiden' queen is another construct without which the male kingship would be nothing as evident from Vijaya's firm refusal to be consecrated as the king without a "maiden of a noble house" as his queen.

CONCLUSIONS AND RECOMMENDATIONS

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. Its aim is to aid cultural comprehension, not textual determination of a particular gender. The traditions of being a male in the *Mahavamsa* are not pure male initiatives and require a series of conditions. The conditionality of the creation of a gender is an important finding of this research. This research also revealed the male gender as a vulnerable gender to both the female and other inter-male hierarchies. These male vulnerabilities is a research area that needs further attention.

LIMITATIONS

This research depended on the English translation of *Mahavamsa* by Wilhelm Geiger. This researcher understands that translation is not straight forward simple act – but a political one. Translation, according to Venuti (2000), 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 'translation' by Geiger despite his best intentions. .

The male explored in the *Mahavamsa* by no means represent a single male identity of the country owing to the multi-ethnic and religious nature of Sri Lanka. *Mahavamsa* primarily focuses on Sinhala kings and queens who lived during a particular historical period in Sri Lanka.

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**JUVENILE JUSTICE IN THE LEGAL SYSTEM OF SRI LANKA:
REFORMS FOR IMPROVING THE STATUS OF CHILDREN IN CONFLICT WITH
THE LAW**

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INTRODUCTION

Juvenile justice is an important area of children's rights which affects the lives of children in conflict with the law and child victims of crimes and offences. Due to the importance of this area of law, international standards have been set on juvenile justice by the United Nations and other agencies. The Convention on the Rights of the Child, (CRC) requires State Parties to establish laws, procedures, authorities and institutions promoting the dignity of children suspected of having infringed the penal law and recognizing their human rights and fundamental freedom. It also recommends formulation of appropriate measures to deal with children outside judicial proceedings and adoption of a variety of interventions such as care, guidance and supervision orders, counseling, probation, foster care, education and vocational training programmes. Other UN instruments such as the International Covenant on Civil and Political Rights (1966) which recognize the due process rights of both adults and children and the UN Standard Minimum Rules for the Administration of Juvenile Justice (1985) known as the Beijing Rules and the UN Rules for the Protection of Juveniles Deprived of their Liberty (1990) also prescribe international standards to the effect that every child deprived of liberty shall be treated with humanity and respect for the inherent dignity of the human person and shall be separated from adults unless it is considered in the child's best interest not to do so. Cases in foreign jurisdictions such as *Re Gault*, decided in the United States in 1969, has introduced standards by stating that the freedom of the juvenile should not be curtailed without affording him due process rights.

In the local sphere, Articles 11 and 13 of the Constitution (1978) ensure that no persons including children should be subject to torture, cruel, inhuman and degrading treatment or punishment and enjoy freedom from arbitrary arrest, detention and punishment. In giving effect to these constitutional provisions, cases such as *Malsha Kumari* have provided relief to a girl child whose above mentioned rights were violated by the police in subjecting her to cruel, inhuman or degrading treatment. The Children and Young Persons Ordinance No: 48 of 1939 (CYPO) provides for the establishment of Juvenile Courts to deal with juvenile delinquents and children in need of care and protection and for procedure for proceedings in the Juvenile Courts or and also provide for Magistrate's Courts to function as Juvenile Courts in the absence of a Juvenile Court. Two juvenile courts have been established in Colombo and Jaffna and the Magistrate's Courts in the rest of the country nominally sit as Juvenile Courts when cases relating to children are heard. A Probation and Child Care service and institutional framework of Remand Homes, Certified Schools and Children's Homes have been established for the rehabilitation and correction of children who come under their purview. An amendment introduced to the Evidence Ordinance in 1995 dealing with contemporaneous recording of evidence admissible in court proceedings created the background for recording of evidence of child victims of sexual abuse immediately after the incident.

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Objectives of the research

1. To undertake a thorough study regarding the present Sri Lankan law and procedure on juvenile justice in terms of international standards with a view to ascertaining the extent to which the present law and procedure meet such international standards and to identify inadequacies in the present law and procedure on this aspect in Sri Lanka.
2. To study carefully the law and procedure in developed countries like Australia, United Kingdom and United States and explore the different kinds of new techniques these countries have adopted in protecting the rights of children involved in juvenile and criminal proceedings.
3. To propose a juvenile justice system for Sri Lanka covering both substantive law and procedural aspects which promote the rights of children both juvenile delinquents and victims of crime in terms of modern techniques adopted by other countries and the international standards.

METHODOLOGY

The study consisted of collecting both primary and secondary data. Secondary data was based on legal literature such as international instruments, research papers, books, journal articles, documents, statutes, and judicial decisions available on the subject in Sri Lanka and in developed countries such as United States, United Kingdom etc. The standards specified in this legal literature were used to carry out a comparative study in the research analysis and also to develop suitable proposals for reform in the Sri Lankan law. For primary data collection, visits were made to the only two Juvenile Courts in the country situated in Battaramulla in the Western Province and in Jaffna in the Northern Province to observe 88 cases involving children. Similar cases in the Magistrate's Courts in these two provinces such as Mount Lavinia, Gangodawila, Jaffna and Chavakachcheri were monitored to compare their procedure and treatment of children with those of Juvenile Courts. Additionally cases in the Magistrate's Courts of Anuradhapura, Kurunegala and Galle outside these two provinces were monitored to observe any differences. The total numbers of cases observed in the Magistrate's courts were 51. Similarly 44 cases in the special High Court set up in Anuradhapura to hear children's cases were observed to ascertain the innovative procedure adopted therein. Though visits were made to High Courts in Kurunegala and Galle no cases involving children could be observed. Interviews were also conducted with 22 girls and 12 boys in Remand homes and Certified Schools situated in the Western Province in Rammuthugala and Makola to obtain their views and experiences. Eight Probation Officers in Colombo, Jaffna, Anuradhapura and Galle, five law enforcement authorities and five legal practitioners were interviewed for the purpose of obtaining their professional opinion on the practical aspects of implementation of the law. Since permission to interview judges was refused by the Judicial Service Commission, a questionnaire was used to collect the opinions of 15 judicial officers in the Magistrate's Courts and High Courts but only five responded.

RESULTS AND DISCUSSION

The research revealed that certain standards set by the CYPO regarding confidentiality of children's cases, non exposure to adult cases in criminal proceedings, notification to Probation Officers by the police when they apprehended a delinquent juvenile or a child in need of care and protection and the international standards that stress the due process rights of the child in conflict with the law, the detention pending trial only as a measure of last resort and for the shortest possible period of time etc have been observed in the breach in the administration of juvenile justice in the Magistrate's Courts. The research revealed that this was due to deficiencies in the structure of the juvenile justice system in Sri Lanka and procedural irregularities committed by some of the law enforcement officials and even by judicial officers. Interviews with resource persons and children revealed that suspected

juvenile offenders had been assaulted at the police stations, detained in the police cell with adults overnight and escorted handcuffed to children's homes by public transport or transported in prison vehicles with adult prisoners thereby violating international standards.

A comparative study of juvenile justice systems in the United States, Scotland, England and India indicate that they focus on restorative justice i.e. reform, rehabilitation and reintegration of the juvenile and out of court settlement of juvenile problems. Detention is used only as a measure of last resort. Interviews with Probation Officers revealed that these standards could be promoted and detention could be brought to a minimum if proper procedures are introduced and judicial officers and law enforcement authorities have a good understanding about the provisions of the statutes such as the CYPO and the Probation of Offenders Ordinance.

The CYPO deals with two types of children i.e. juvenile offenders and children in need of care and protection. Emphasis on retributive justice i.e. punishment of the offender who attempted to challenge the State authority, a value system that is embedded in the adult criminal law, has influenced the juvenile justice system to forget the main objectives of a restorative juvenile justice system that envisages not the punishment of the juvenile offender but make him/her understand that his/her conduct was wrong and should be held accountable for such conduct. This misunderstanding has obscured the standards set out by the CYPO and has led to violation of its provisions. Interviews with resource persons also indicated lack of child care professionals in the field and lack of knowledge of child psychology for child care workers and law enforcement authorities and inadequate adoption of social care policy in child care services inhibited the successful integration of child offenders and children in need of care and protection into the society.

On a positive note, it was found that the two Juvenile Courts in Battaramulla and Jaffna, especially the Juvenile Court in Battaramulla, had established rooms for a play area and resting, a legal aid centre within the court premises creating a child friendly atmosphere. In contrast, the situation at the Magistrate's Court was different, due to its nature as a criminal court of first instance to punish adult offenders and as a result have not been able to meet the juvenile justice standards set by international instruments and the CYPO. The overcrowded court house together with uniformed staff and lawyers with different uniforms signifying their authority is not child friendly but intimidates a child. Though the Supreme Court has taken, in the recent past, commendable measures to set standards for the treatment of children and improve the situation of children in detention centers, the weaknesses in the structure of the court system and legal procedures have prevented safeguarding the rights of children in conflict with the law. It was revealed that at the Magistrate's Courts many children in conflict with law do not get legal representation unless lawyers were retained by their parents on their behalf. This infringes s. 5 (1) (d) of ICCPR Act No: 56 of 2007 which recognizes the right to legal counsel as a human right.

It was observed that official apathy, non availability of resources and financial allocations has adversely affected every institution that deals with children. It was found that methods directed at protecting child witnesses in criminal proceedings such as the admissibility of video recording of evidence of a child at the time of incident at later court proceedings introduced by an amendment to the Evidence Ordinance is confined to the statute book and is not implemented in High Court proceedings except in a single case. Courts have not been able to adopt techniques such as use of a curtain or one way communication method by keeping the child in a separate room in the court house and relaying his/her image to the court where proceedings take place in order to shield the child witness from the gaze of the accused, to safeguard the interests of the child witness in criminal proceedings. Poor salary, insufficient cadre provisions and lack of promotional prospects of staff at Remand Homes, Certified Schools and Children's Homes, have led to lower their morale. The vocational training courses offered at Certified Schools have been reduced to minimal numbers and

sexual abuse of young children by older children take place during the night in some homes due to lack of sufficient staff. Probation Officers face the same problems discussed above and insufficient transport allowance badly affects their performance of duties such as visiting individual homes of children in remote areas to provide social reports on them to courts.

CONCLUSIONS AND RECOMMENDATIONS

The research suggests that a major shift from retributive justice to restorative justice in the juvenile justice system in Sri Lanka which gives more emphasis to diversion of juveniles rather than detention needs to be undertaken. This will pave the way for out of court settlement of problems of juvenile offenders through the adoption of methods such as releasing child offenders in minor cases on police bail after a meeting with all parties including parents, the offender and the victim with the involvement of police and Probation Officers. For this purpose amendment to existing statutes, correcting procedural irregularities and adoption of a social oriented approach is necessary. The success of the Juvenile courts, especially the one in Battaramulla with its child friendly atmosphere and in contrast the inherent weakness of the Magistrate's Courts sitting as Juvenile Courts suggest the necessity of establishing Juvenile Courts in all judicial districts. As an initiative for this task, one day of a week may be allocated in all Magistrates' Courts to sit as a separate Juvenile Court until such time separate Juvenile Courts are established by the State. Similarly the success of the Special High Court at Anuradhapura dedicated to disposing of child sexual abuse cases within a short period of time also suggests that at least one day of the week should be dedicated to hearing cases involving children in High Courts.

Legal provisions should be introduced to provide the child in the legal process with legal representation and appointment of *guardian ad litem* in care proceedings. Similarly resources and infrastructure facilities of courthouses should be improved for the adoption of previously discussed techniques and for the implementation of the provisions of the Evidence Ordinance relating to contemporaneous recording of video evidence of the child to create a child friendly procedure at the adult court house. Income collected from imposition of fines by the court system can be utilized to introduce these new techniques.

Introducing a distance mode course on social science with emphasis on child psychology and social integration of child offenders, for child service providers and law enforcement authorities will enhance their knowledge on child care services. The development of non-custodial methods of rehabilitation and their integration into the procedure will enhance the re-integration process of children in conflict with the law successfully. Similarly the child service providers including the law enforcement authorities and judicial officers should be exposed to the knowledge of international standards in juvenile justice, the provisions of the CYPO, Probation of Offenders Ordinance and other statutes that deal with children. Increasing financial allocations for Probation and Child Care Services, cadre provisions, traveling allowances, providing promotions for child care service providers such as Probation Officers and staff at Certified Schools and Remand Homes, maintaining upto date vocational training programmes, improving the infrastructure facilities at these institutions and providing an efficient transport system for juveniles in conflict with the law is necessary for the promotion of juvenile justice in the country.

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AN OVERVIEW OF LEGAL PROVISIONS TO ADDRESS CYBER CRIMES - A SRI LANKAN PERSPECTIVE

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INTRODUCTION

“A school girl has committed suicide due to a hacking problem on Facebook”. This has become a common feature on the Sri Lankan news. It is clear that the normal arena for crimes has altered and it is now, increasingly, occurring in cyber space.

In Sri Lanka, the general substantive law that is applicable for criminal activities is Penal Code No 2 of 1833. However, it is a question of the efficacy of the Penal Code to deal with cyber-based crimes. The Penal Code deals with offences against persons and property. It does not define the term “property”. However, the definition of movable property includes “*Corporal property of every description, except land and things attached to the earth or permanently fastened to anything which is attached to the earth*” (Section 20 of Penal Code). In case law, in *Nagaiya V Jayasekera*, 28 NLR 467, it was accepted “that the definition given to property was not adequate to deal with contemporary information and communication technology related offences”. And the attempt to include intangible property within the existing definition of the Penal code was also rejected by the Supreme Court in this case when it held that electricity was not “property” within the meaning of the law.

Since the definition given to “property” and other definitions for wrongful acts in the Penal Code are inadequate to deal with criminal activities such as those involving contemporary information and communication technology, the Committee on Law and Computers of the Council for Information Technology of Sri Lanka proposed the current Computer Crimes Act of 2007 (ACT). However, this Act has not included cyber-crimes within its scope. Therefore, cyber-crimes have not been brought within the ambit of the law.

OBJECTIVE

The objective of this paper is to analyze the capacity of the existing Sri Lankan legal framework to deal with cyber-related crimes and to recommend coverings such crimes either within the existing legislation or, if necessary, by enacting new legislation.

RESEARCH METHODOLOGY

As there are only a small number of cases in the area of cyber crimes in Sri Lanka, this paper adopts analytical methods in considering this topic. This analysis is based on a literature survey of existing legislation. The literature research will include legal enactments, such as statutes, judgments, cases and other published research on cyber-crimes. I have also provided secondary data to support the findings and recommendations of this paper. The information on computer/cyber-crimes in Sri Lanka has been used.

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RESULTS/DISCUSSION

The definition introduced by J.Soma in 1983 of Computer Crime is “the use of computer or its technology as a target of or a tool for illegal purposes”. Generally, a computer crime includes three components. They are computer-related crimes, hacking offences and content-related cyber crimes. Computer-related crimes are those where computers are used as a tool for criminal activity, such as theft and fraud, while hacking offences are those that affect integrity, availability and confidentiality of a computer system or network (including the introduction of viruses, worms, etc). Content-related cyber-crimes are those where computers, together with internet resources, are used to distribute illegal data.

E.g., internet-based pornography and criminal copyright infringement.

The Sri Lankan ACT 2007, which deals with crimes related to Information Technology in Sri Lanka, has only the first two components, and it does not include the third component, content-related cybercrime. In terms of the scope of this Act, Section 2 would apply where-

- (a) A person commits an offence under the Act while being present in Sri Lanka or outside Sri Lanka
- (b) The computer, computer system or information affected, by the act which constitutes an offence under this Act, was at the material time in Sri Lanka or outside Sri Lanka.
- (c) The facility or service, including computer storage or information processing service, used in the commission of an offence under this Act, was situated in Sri Lanka.
- (d) The loss or damage is caused within or outside Sri Lanka by the commission of an offence under the Act, to the state or to a person resident in Sri Lanka or outside Sri Lanka.

Identified offences under the ACT 2007 are offences relating to unauthorized access (section 3), ulterior intent offences (section 4), unauthorized modification of material (section 5), offences against national security, public security and the national economy (section 6), involvement with data illegally obtained (section 7), illegal interception of data (section 8), using of illegal devices (section 9), unauthorized disclosure of information enabling access to a service (section 10) and attempts to commit offences and abetment and conspiracy (section 11). According to the above mentioned substantive offences, it is understandable that the Act covers a broad range of offences that could fall into the computer-related crimes and hacking offences categories, and not to the content-related cyber crime category. Sections 15 to 24 of this Act contain the provision on the investigative procedure. Sections 109-125 from the Code of Criminal Procedure Act No 15 of 1979 are also applicable regarding investigative procedures.

It is important to identify the differences between computer crimes and cyber crimes. According to Jayantha Fernando, the director of the ICT Agency of Sri Lanka, computer crimes are non-traditional crimes that arose directly from the advent of the age of personal computing for managing information and communication. Cybercrimes are criminal activities committed through the use of electronic communications media. Cybercrime includes activities such as unauthorized access to IT systems, the hacking of bank accounts, identify theft, confidential data theft and alteration, denial of services attack, Phishing, SPAM, and the theft of intellectual property.

Cyber crimes are no longer a novel concept in Sri Lanka. Sri Lanka is a signatory to the International Cyber Crime Convention. In addition to this, Sri Lanka has signed the UN

Electronic Communications Convention in 2006, which is known as the Budapest Convention on Cyber Crime. Signing this convention allows Sri Lanka to have access to computer systems and networks in other countries, and facilitate the gathering of electronic evidence, investigation of cyber laundering, cyber terrorism and other serious crimes.

However, cybercrimes still remain outside of the scope of national legislation. As there are no relevant provisions in the Computer Crimes Act of Sri Lanka or a separate legislation to deal with cyber crimes, it has been the practice to use the Intellectual Property Act 36 of 2003 and the Penal Code Amendment 2006 in relation to dealing with such cases. Further, the Electronic Transactions Act 19 of 2006 would be applicable to govern evidence under the Computer Crimes Act. However, this Act is silent on this matter. Unfortunately, these are insufficient to handle cyber crimes and their investigations.

South Asian countries such as Sri Lanka and India have adopted a legal framework on computer crime based on the Budapest Convention on Cybercrime. Other countries in the region, such as the Maldives and Pakistan, are in the process of adopting similar frameworks. India, by the amendments in 2006 and 2008 to the Information Technology Act of 2000, gives attention to cybercrime. In this context, new challenges crop up for Sri Lanka.

CONCLUSION/RECOMMENDATION

Cybercrimes have not occurred in any substantial scale in Sri Lanka. However, now they are beginning to make their appearances. In any case, Sri Lanka is a party to the International Convention on Cyber Crimes. Therefore, it is now an obligation to include such crimes in existing legislation or to enact new law on this subject. With modern developments in Information Technology, it becomes necessary for us to be aware and be informed about cybercrime. When we go through the number of computer crime cases in the past years, after the enactment of the Act, from 2007 to 2011 there has been 178 reported cases. (Presentation of M.K.D. Wijaya Amarasinghe, Director/ Criminal Investigation Department). However, now about 2,000 complaints are received annually and about 200 complaints monthly. Most of the current complaints are related to privacy breaches and hackings on social media networks such as Facebook (Sri Lanka CERT-CC Chief Executive Officer, Lal Dias). There may be a large number of unreported cases. The government has to take necessary steps to educate people, from school children, because these days many school-age children have Facebook accounts.

The suggestions by the Council of Europe could help Sri Lanka to increase our capacity of criminal justice authorities, such as the Electronic evidence guide (for law enforcement officers, prosecutors and judges), first responders' training pack (for law enforcement officers), the Basic judicial training course (for prosecutors and judges) and the advanced judicial training course (for prosecutors and judges).

According to the Senior Minister of Scientific Affairs, Professor Vitharana, cybercrime offences occur across traditional territorial boundaries, and Sri Lanka cannot remain isolated and must be in a position to cooperate internationally in an efficient manner. Therefore, the framework proposed by the Convention on Cybercrime of the Council of Europe should be adopted meaningfully in Sri Lanka. The existing legislation and litigation is not sufficient to overcome the ever increasing computer/cybercrimes. Therefore, there is a need for new security measures, in addition to the existing ones.

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STUDENT REPRESENTATION IN THE OPEN UNIVERSITY: A CASE FOR STATUTORY INTERPRETATION

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INTRODUCTION

This study is undertaken in the backdrop of much argument and controversy about the role of students in decision making at universities. It is written at a time when student unions have been dissolved, and union activity is at a standstill. Having heard the issue being hotly debated in many arenas, the author ventures to study the position from the point of view of statutory interpretation. I am aware that the issue may be settled bylaw by the time this study is presented and that the conclusions I arrive at maybe at variance with what is deemed to be law. However the debate raises many interesting issues which may be analyzed from the perspective of statutory interpretation.

One of the key issues surrounding this debate is the respective roles of the Universities Act of 1978 and The Open University Ordinance No 1 of 1990. Therefore the central focus of this paper is on how primary legislation (the Universities Act) and delegated legislation (the Open University Ordinance) are dealt with in statutory interpretation.

The objectives of this study are to

- Consider the key statutory provisions on the issue of student representation
- Apply the rules of statutory interpretation to these provisions and consider the probable outcome

METHODOLOGY

This research is normative in nature. It will involve documentary analysis of statutory provisions and relevant case law in arriving at the conclusions to the study.

RESULTS AND DISCUSSION

Laws governing the Open University of Sri Lanka

The primary law governing universities in Sri Lanka is the Universities Act of 1978 as Amended. Section 23(1) of this Act empowers the Minister in consultation with the Commission (University Grants Commission) by an Order to establish an Open University. Section 23(2) states that the structure, duties, powers and functions of the Open University shall be prescribed by Ordinance. Section 26 requires such University Order to be published in the Gazette and be tabled in Parliament. Section 27 lays down a similar process for the amendment, revocation or variation of a University Order.

The Open University of Sri Lanka was established in accordance with the above provisions by the Open University of Sri Lanka Ordinance No. 03 of 1980. However both this Ordinance and the subsequent one i.e. Ordinance No. 01 of 1987 were later repealed. The presently applicable law therefore is Ordinance No. 01 of 1990 which was published in the Gazette Extra-Ordinary of 5th January 1990. Ordinance No 01 of 1990 has been amended by a series of amendments, namely Ordinance No. 12 of 1996, Ordinance No 03 of 2005, Ordinance No. 01 of 2007, Ordinance No. 01 of 2008, Ordinance No. 01 of 2010 and Ordinance No 01 of 2013.

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Legal Provisions Regarding Student Representation in the Universities Act

Section 48 of the Universities Act as Amended by Section 27 of Amendment No 07 of 1985 requires each faculty to have a Faculty Board the composition of which is to include, 'two students elected by the students of the Faculty from among their number. [Section 27 (1A)(e)] Further mention of student unions is to be found under Part XIV of the Universities Act. The part which originally consisted of seven sections (Sections 112-118) has undergone significant amendment resulting in 3 of the sections (i.e. Sections 113, 114 and 117) being repealed.

Section 112 has been altered significantly. The section originally provided for a 'Student Assembly', members of which were selected by a secret ballot at the beginning of the academic year. Such members held their posts for that academic year.

Amendment No 7 of 1985 replaced 'Student Assemblies with 'Student Relations Councils' by an amendment made to Section 112.A 'Student Relations Council' was to consist of 'such number of staff and students as may be prescribed by Ordinance, from among persons who are for the time being members of the staff and students respectively, of that Higher Educational Institution.'

Amendment No 26 of 1988 repealed the above provision and replaced it with the presently applicable section. The present Section 112 states that each Higher Educational Institution 'shall' have a University Student Union and a Faculty Students' Union. The mode of conducting elections to elect office-bearers to the Union 'shall be' prescribed by by-laws of the governing authority of the relevant institution.

Section 118 (1) provides as follows; 'If any union or society or other association of a Higher Educational Institution conducts itself in a manner, which, in the opinion of the principal executive officer of that Institution, is detrimental or prejudicial to the good name of that Institution, obstructs the proper administration of that Institution, or acts in contravention of this Act or any appropriate Instrument, such principal executive officer may suspend or dissolve such union, society or other association, as the case may be'.

Originally 118 (2) provided that in the case of a 'Student Assembly' being dissolved under Section 118(1) 'the Chief Executive Officer may fix a date for election of a new Student Assembly which is to hold office until the end of the academic year in which it was elected'. However Section 118(2) was subsequently repealed by Section 63 of Amendment No 7 of 1985. It is noteworthy that this is the same Amendment which replaced 'Student Assemblies with 'Student Relations Councils' and removed specific mention of student election from Section 112 until it was repealed in 1988.

Student Representation and the Open University Ordinance

A study of the Open University Ordinance itself leads to some confusion as there does not appear to be any specific mention of student participation in University activities. Section 18(1) of Ordinance No. 01 of 1990 which deals with the establishment of Faculty Boards did not make any mention of students as originally enacted. However when the Ordinance was amended by Amendment No. 12 of 1996 it appears that the inclusion of students was automatically presumed.

Originally Section 18(2) contained a list of 6 categories of persons who comprised the Faculty Board. These persons were listed in 6 sub sections to Section 18(2) (i.e. Section 18 (2) i- vi) Section 2 (f) of the Amendment of 1996 introduced two more categories, inserting them into the middle of the list and renumbering them. Logically this should have led to the list ending in viii. However Section 2 (f) (iii) states that Section 18 is amended 'by the renumbering of clauses (vi) and (vii) ...as clauses (viii) and (ix) thereof' (Emphasis added). This is the first

mention of a Section 18 (2) (ix).

The Amendment of 1996 also added a new Section 18 (3) to the Ordinance. Section 18(3) (i) sets the period a person in category ix could be a member of the Faculty Board as one year. Further Section 18 (3) (ii) excludes such members from proceedings of the Faculty Board relating to election of a Dean, and matters connected to examinations.

The author as failed to discover, within the University, any amendment to the Ordinance between 1990 and 1996 by which the section which is now Section 18 (2) (ix) was introduced. However Section 18(3) seems to indicate that it refers to students who as a practice have been excluded from Faculty Boards during discussion of the matters mentioned in that section. There is however a consolidation of the Ordinance of 1990 and the 1996 Amendment which sets out Section 18 (2) (ix) as 'Two students elected by the students of the Faculty from among their number'. The source of the consolidation however is not indicated though it appears to be aimed at correcting an obvious omission in the Ordinance by reference to the Universities Act.

It is noteworthy that Section 18 (2) (ix) is identical to that contained in the Universities Act discussed above. Therefore it appears that this section has been incorporated by virtue of Section 23 of the Ordinance which states that where there is no provision in respect of any matter in the Ordinance the provisions in the Act shall *mutatis mutandis* apply.

The Open University Student Association By-Law No. 3 of 2000 (Amended of 30th April 2010) has put in provisions to establish student associations. These provisions enable students to elect 13 members by ballot to each Faculty Student Association [Section 3 (iii)]. Section 3 (iv) (b) requires these 13 members to then elect 2 members from among themselves 'to ensure student representation in the Faculty Boards'. Further Section 18 (1) requires The Principal Executive Officer to call for the first meeting of the Association in order to elect the said 2 members to the Faculty Board. Further Section 18 (iv) provides that such Faculty Student Association 'shall' hold at least one meeting for each month of the Student Association year. Section 19 provides for the members to hold office for a period of one year, while Section 20 makes provision for a replacement for the unexpired period of any member's time if they cease to be members. This latter provision would apply to student representatives to the Faculty Board as well. All these provisions clearly envisage the existence of a smooth and continuously functioning Student Association.

Implications of the provisions on Student Representation

The provisions above give rise to several questions

- Is the Open University bound to have student representatives in the Faculty Boards?
- Are the existing By- Laws sufficient to cover all situations which may necessitate the holding of elections?
- Does repeal of Section 118 (2) mean that it is impossible to hold elections once a union is dissolved under Section 118(1)?

Role of Delegated Legislation

As stated by Bennion (2008;241) delegated legislation is an instrument made by a person or body (the delegate) under legislative powers conferred by an Act (the enabling Act). Bennion further states (2008;243) that the essential function of delegated legislation is to carry out the purpose of the enabling Act, and that such legislation cannot as stated in *Re Davis exp Davis* (1872) override any Act, and certainly not the enabling Act itself. Bennion states that since the legislature cannot consider all details, it lays down an outline, which is the enabling Act in which the intention of the legislature is embodied. Thus the enabling Act is the prime guide to the meaning of the delegated legislation and the extent of power to make it. *Utah*

Construction and Engineering Pty Ltd v Pataki (1966) stated that delegated legislation ‘does not enable the authority by regulations to extend the scope or general operation of the enactment but is strictly ancillary. It will authorize the provision of subsidiary means of carrying into effect what is enacted by the statute itself and will cover what is incidental to the execution of its specific provision. But such a power will not support attempts to widen the purpose of the Act, to add new and different means of carrying them out and to depart from or vary its ends’.

The above discussion makes it clear that the enabling Act takes precedence over the subsidiary legislation so that it cannot depart from the intentions expressed in the Act. Although Section 23(2) states that the structure of the Open University should be prescribed by Ordinance this should be read together with Section 18 (1) which empowers the Commission to make Ordinances in respect of all such matters it may deem necessary to enable it to effectively exercise, perform and discharge its powers, duties and functions under the Act. Further Section 18(2) empowers it to make ordinances regarding all matters to be prescribed by Ordinance, by any other provision of the Act. Thus it seems implicit that the Ordinance cannot deviate from the spirit of the Act and that student representation is a mandatory requirement.

The above discussion also emphasizes the need to read the Universities Act and Open University Act together so that gaps in the Ordinance maybe filled as appears to have happened with regard to Section 18 (2) (ix) of the Ordinance.

Mandatory and Directory Provisions

The Act states that there ‘shall be’ University Student Unions and Faculty Student Unions, and that the mode of election ‘shall be’ prescribed by by-laws. All directions in this regard appear to be mandatory in nature. As Bennion states the effect of failure to comply depends on ‘whether the persons affected and the persons bound are the same and whether the thing done is beneficial or adverse to the persons affected’. If the direction is mandatory, failure to comply invalidates the thing done and gives the court discretion as to whether to enforce the duty whereas if it is directory the law will not be invalidated. Lord Penzance in *Howard v Bodington* (1877; 211) has stated that in trying to arrive at the intention of Parliament as to whether a provision is imperative or directory, ‘you must look to the subject matter, consider the importance of the provision and the relation of that provision to the general object intended to be secured by the Act’. Pearce and Geddes (2011) state that subject to the context in which the words are used, words such as ‘shall’ or ‘must’ prima facie impose an obligation to exercise that function whereas the use of the word ‘may’ will not be considered imperative unless such meaning is clear from the entire Act.

Clearly the Universities Act has a saving clause which prevents Acts becoming invalidated. However it appears from the wording of the Universities Act that the requirement for Student representatives set out in Section 112 is a mandatory provision. This is further supported by the mandatory requirement for the relevant institution to prescribe by-laws on elections. The University By-Law discussed above has made such provisions. The provisions for students to be represented at Faculty Boards as well as for the Principal Executive officer to call for the first meeting to elect these representatives are also clearly stated in mandatory terms. Further all the other provisions discussed above clearly envisage the continuous presence of student representatives at Faculty Boards. However the By-Law does not state when an election can be called for, which is in accordance with Section 112 of the Universities Act which only requires the mode of election to be set out in the By-Law. However, when the Act and the By-Laws are read together a clear intention for the continuous presence of students in the Faculty Boards where decision making directly affecting them takes place, is apparent.

Giving effect to the purpose of the statute, the most beneficial interpretation

Amendment No 7 of 1985 by the amendments to Section 112 and 118 appears to have intended to remove the procedure of electing students from the Act. However the need for student representation and some form of organized student body whether known as Assembly, Student Relations Council or Union appears to run uninterrupted throughout the Act. The removal of a procedure for election is remedied by the mandatory provision to enact by-laws on the matter which was brought in by the Amendment of 1988. Why was some provision to hold elections once a union was dissolved under Section 118 not put in at the time of enacting No 7 of 1988? Does this mean that unions forever cease to exist once a particular union is dissolved? Can the mere repeal of a section dealing with dissolution of a union be intended to bring about such a drastic change? Or is this a case where the use of literal interpretation can lead to absurdity? As stated by Lord Millett in *R (on the application of Edison First power Ltd) v Central Valuation Officer and Another* [2003;116] ‘Courts will presume Parliament did not intend a statute to have consequences which are objectionable; or absurd; or unworkable or impracticable or merely inconvenient; or anomalous or illogical; or futile or pointless’ Would not then a purposive interpretation be more appropriate to give effect to the intention of Parliament, arrived at by looking at the process by which the law has ended up at its current unclear position? As Bennion states, when the purposive rule of statutory interpretation is adopted it maybe purposive-and-literal or purposive-and-strained. The purposive strained approach was adopted by Lord Steyn in *AG’s Reference (No 5 of 2002)* where he stated that ‘No explanation for resorting to a purposive construction is necessary. One can confidently assume that Parliament intended its legislation to be interpreted not in the way of a black-letter lawyer, but in a meaningful and purposive way giving effect to the basic objectives of the legislation’.

Although the By-Laws on Student Associations do not specifically mention a situation where a union is dissolved under Section 118, the Universities Act does not require it to do so. However the mere fact of the mandatory wording in setting out the requirement for By-Laws, could, it is argued, be considered a consequential amendment to Section 118.

Further the purpose of Section 112 of the Universities Act is to establish Student Associations [Section 112 (1) to establish them and 112 (2) to set out the mode for electing members to them] while Section 118 seems to have as its objective the protection of the university against wrongful activity of particular unions. The two purposes are clearly different. Would it not then be against the very purpose of the Act, to penalize the entire student body, by denying them the right to a voice in decision making, due to actions of a particular body elected for one academic year? Should not Sections 112 and 118 be read together as complementary (instead of being considered contradictory) so that when an Association ceases to exist, for whatever reason,(including dissolution under Section 118), steps should be taken for a new election? It is submitted that such a purposive construction would be more in consonance with all the relevant provisions and the spirit of the law.

CONCLUSIONS/RECOMMENDATIONS

The following conclusions maybe arrived at from the preceding discussion;

- that the Universities Act should be given priority and that the Ordinance should be read together with the Act
 - That student bodies and modes of creating those bodies are mandatory provisions of the Act
 - That the Act must be read as a whole and not in isolation and the intention of Parliament should be given effect to.
 - That single provisions must not be read in a manner that renders other provisions futile and that a consequential amendment maybe inferred in this instance.
- Accordingly it is further concluded that
- The Open University is bound to have student representatives in the Faculty Boards.

- Existing By- Laws are sufficient to cover all situations which may necessitate the holding of elections.
- The repeal of Section 118 (2) does not make it impossible to hold elections once a union is dissolved under Section 118(1).

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**BALANCING TRADEMARK RIGHTS AGAINST RIGHT TO HEALTH: AN
ANALYSIS WITH REFERENCE TO THE RECENT CASE OF CEYLON
TOBACCO COMPANY PLC V. MINISTER OF HEALTH**

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INTRODUCTION

Trademarks have long been used by manufacturers and traders to identify their goods and to distinguish them from goods made or sold by others.¹ In the modern commercial era, trademarks also serve as incentive for producers to maintain their competitiveness and stability of business. Article 15 of the Agreement on the Trade Related Aspects of Intellectual Property Rights (TRIPS) states that, *any sign, or any combination of signs, capable of distinguishing the goods or services of one undertaking from those of other undertakings shall be capable of constituting a trademark*. A glimpse of the Sri Lankan Intellectual Property regime reveals that trademark rights are well protected under the current Intellectual Property Act No.36 of 2003.²

From a different perspective, the right to health has been enshrined in many international agreements including Article 25 of the Universal Declaration of Human Rights (UDHR) and the Article 12 of the International Covenant on Economic, Social and Cultural Rights (ICESCR) as a significant and indispensable human right.³ The preamble of the 1946 World Health Organization (WHO) Constitution defines the right to health as "*...the enjoyment of the highest attainable standard of health*". However, the Sri Lankan Constitution does not recognize the right to health as a fundamental right of the citizen. Neither is there any reference to the right to health in the Directive Principles of the state policy.⁴ Nevertheless, the Sri Lankan Supreme Court has given an implied recognition of the right to health in some cases relating to environmental matters.⁵

In the light of the foregoing, this research examines whether there is a conflict between trademark rights and the right to health. It should be pointed out that the 'Right to Health' has two main dimensions: first, right to access to health care; second, the obligation of the State to take measures to safeguard public health.⁶ Thus, in fulfilling the latter, the State has an obligation to impose rules and regulations to mitigate the adverse impact of individual rights such as that of trademark rights on public health. Therefore, the law needs to strike an appropriate balance between these conflicting interests.

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¹ Vadi, S. Valentina. (2009). Trademark Protection, Public Health and International Investment Law: Strains and Paradoxes. pp. 773-803. EJIL. Vol 20 No.30

² Intellectual Property Act No.36 Of 2003, Sections 101 to 122 deals with providing safeguards on trademark rights. See also, *Stassen Exports Ltd. V. Hebtullabohy & Company Ltd.* (1989) 1 Sri LR.189.

³ See also, Article 24(1) of the Convention on the Rights of the Child, American Convention on Human Rights, Protocol 1, Article 10.

⁴ However, Article 27(2)(c) of the Directive Principles acknowledges the state commitment towards protecting environmental health which includes the 'continuous improvement of living conditions'.

⁵ *Deshan Harindra (a minor) v. Ceylon Electricity Board* 1998 5 (4) S.A.E.L.R. 116. In this case, the Supreme Court held that severe noise pollution can adversely affect young children's health and using such machinery is a violation of 'right to life'.

⁶ Symonides, J. (2000). Human Rights; Concepts and Standrads. At p. 152. New Delhi. Rawat Publications.

In dealing with this contentious issue in Sri Lanka, the present study focuses on the recent decision of the Court of Appeal in *Ceylon Tobacco Company PLC vs. Minister of Health*⁷. As per the facts of this case, Sri Lanka's Ministry of Health adopted regulations requiring tobacco products to contain graphic pictorial health warnings covering 80 percent of the pack. The Ceylon Tobacco Company challenged the regulation arguing that the regulation exceeds the authority and power vested in the Ministry, *inter alia*, violates the company's intellectual property (IP) rights, in particular, its trademark rights. In its judgment, however, the court reduced the size of the warnings to cover 50 to 60 percent of the cigarette pack in order to give tobacco companies more space for displaying their trademark.

Thus, the main objective of this study is to evaluate the approach adopted by the Court of Appeal in balancing the need to protect public health against the rights of a business to use its trademark to facilitate, identify and sell its products.

METHODOLOGY

The study was carried out as a library based research. Both primary and secondary sources were used to collect data. The Primary Sources consisted of Case Law which addresses the conflict between trademark rights and the right to health, International Conventions and relevant Legislative Instruments, particularly the Intellectual Property Act No.36 of 2003 of Sri Lanka, and other selected jurisdictions. As per Secondary Sources Text Books, Research Articles on the subjects, Journals and some Statistical Reports of relevant institutions were used extensively. In addition, an analysis of comparative jurisdictions relating to this topic was used.

RESULTS AND DISCUSSION

First and foremost, it should be mentioned that the debate on right to health and trademark rights can be considered as a prominent example in examining the conflict of rights. The conflict arises between these two rights based on the (tobacco products labeling and packaging) Regulation No. 01 of 2012, which has been enacted under Section 34 of the National Authority on Tobacco and Alcohol Act No.27 of 2006. The petitioner of the case⁸ argued that a writ of Certiorari be issued to quash the aforesaid regulation.⁹ Furthermore, in this instance, the court as an interpreter of the statute had a Herculean task to strike a balance between the right to health and trademark rights. The Appeal Court of Sri Lanka had, on this occasion, taken up the task of social engineering in analysing the case of *Ceylon Tobacco Company PLC v. Minister of Health* using a novel approach.

Secondly, it can be identified that the conflicting interests of the right to health and trademark rights can be harmonized by using the principle of proportionality¹⁰. The very interesting fact here is that even though the principle of proportionality deals with the area of Administrative Law, the learned judges had prominently used it to harmonize two contrasting rights. Thus, considering legal, social as well as economic aspects; the Court had decided to limit Tobacco PLCs' trademark rights, on the one hand, and the court had not accepted the 80 percent of pictorial warning of the lawmakers, on the other hand. Instead, the Court directed the parties to use pictorial warnings in the range of 50-60 percent of the space. The argument of the court is as follows:

" I am of the view that 20 percent of the space is not reasonably sufficient to present and

⁷ *Ceylon Tobacco Company PLC v. Minister of Health* CA 336/2012 (Writ)

⁸ Ceylon Tobacco Company PLC.

⁹ *Supra* foot note 07 at p. 03

¹⁰ The Principle of proportionality indicates that administrative measures must not be more drastic than are necessary for attaining the desired result. It can be summed up in a phrase "not taking a sledgehammer to crack a nut".

exhibit a trademark, 20 percent of the space is not exclusively left for the trademark...on the other hand a legally established business/industry cannot be denied its legitimate rights, flowing from the laws of the country. If 80 percent of the space is covered by health warning the remaining space would not be sufficient to display the manufacturer's trademark...however it is the view of this court that pictorial health warning should cover a space between 50 to 60 percent."¹¹

Thirdly, it is observed that, even though the trademark owners' legitimate rights are protected by courts, the rights of the trademark owner can be subjected to certain limitations imposed by public policy considerations. From a human rights perspective, as it is illuminated in the ICESCR¹², a person has a legitimate right to protect his intellectual property rights. A glimpse of the Article indicates that IP rights have been recognized as human rights by this Convention. In view of that, therefore, when the issue of right to a trademark v. right to health is considered, the court cannot treat it as a mere incident and uphold the right to health. Thus, the court may have to consider the merit of each and every relevant fact before coming to a conclusion. It is noted that in this case;

*"...such a situation will unreasonably interfere with the statutory right of the owner of the trademark to use it, frustrating the whole purpose of a trademark and of the trademark law."*¹³

Fourthly, it is seen that the law *per se* is not operating in a vacuum. It is also combining with the society as a part and parcel thereof. Thus, it is believed that the law should demonstrate the values and aspirations of the society in which it is functioning. This idea is enshrined in the legal philosophy developed with sociological jurisprudence.

*"The science of law cannot be self-sufficient. Viewed functionally, as a technique of social control with a changing purpose in view, it must draw upon other disciplines for insights. Ethics, economics, political science, sociology, social psychology, history, psychology, and philosophy are the disciplines which can be used advantageously to further the purposes of law"*¹⁴

It might well be argued that the very idea is echoed in the judgment of *Ceylon Tobacco PLC. v. Minister of Health*. Therefore, it should be viewed as the court following its wisdom of law by harmonizing trademark rights and right to health taking into consideration social-economic and other factors that can influence the law.

However, this decision may be reversed in future by the Supreme Court. Therefore one can reasonably question the authority of this judgment and its binding force. However, until the contrary is decided, this judgment can be considered as a landmark judgment on the interface of human rights and intellectual property rights and trademark rights in particular.

CONCLUSIONS/RECOMMENDATIONS

Even though the intellectual property laws grant exclusive rights for trademark owners, the public interest consideration would play an important role in determining the extent to which such rights may be exercised. In such a scenario, right to health prevails over intellectual property rights and the court has to act as a harmonizer, mediator, and even a social engineer. Thus, the principle of proportionality can be used as an effective tool to balance conflicting interests in society. However, this judgment neither confirms the right to health an absolute

¹¹ See *Supra* foot note 07 pp.32-35.

¹² See Article 15.1 of the ICESCR

¹³ See *Supra* foot note 07 at p. 33.

¹⁴ Gardner. J. A, (1961). *The Sociological jurisprudence of Rosco Found.* Pp.13- 45 Villanova Law Review, Vol. 07.

which should always be given priority over IP rights, nor does it indicate that the IP rights including trademark rights are subordinate to other public rights.

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AMERICA'S ASIA PIVOT: SINO - U.S. RELATIONS SINCE 2009P. R. Gunaratne¹

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Disclaimer: *The contents of this article are of author's sole responsibility. They do not represent the views of either the Ministry of External Affairs or the University of Colombo*

INTRODUCTION

The unipolar world order spawned since the collapse of the Soviet Union was dominated by the sole military and economic hegemon, the United States (U.S.). Conversely a gradual transition into bipolarity marked by "peaceful rise" of China, juxtaposed with its rapidly growing military superiority has fuelled the suspicions harbored by America and its allies in the Asia-Pacific in an anarchical self-help Westphalian international system. Washington nevertheless seems to have fully come to grips with the reality of systemic changes taking place in the global arena. Hence the Obama Administration has professed the "East Asia-Pacific Rebalance" with the intention of expanding U.S. engagement in the said region and with the motive of encircling, destabilizing and containing China. Relations between these two economic power houses have nonetheless been marked by cordiality *Vis a vis* America's relations with the Soviet Union during the cold war period. Such a strategy broached by the Obama Administration albeit seems to be capricious, was strengthened by Obama's recent visit to Asia.

DISCUSSION

The U.S. nevertheless engages in diplomatic confrontations with China in the recent past where Washington had raised concerns over human rights issues, North Korea, manipulation of currencies, maritime disputes, climate change and cybercrimes. Furthermore the fear psychosis engendered by the U.S. and its allies has been complicit in exacerbating tensions in the South and East China seas. As China is predicted to overtake the American economy in 2030 and to project itself as a superpower by 2049 Beijing has begun to adopt a policy which shall on the one hand position China as the regional hegemon and on the other facilitate the expansion of its influence as the preeminent power in the region. In such a context the U.S. being tasked and burdened with the responsibility of ensuring security of its traditional allies in the region (i.e. Japan, Republic of Korea, Malaysia, the Philippines and Australia) has embarked on a military modernization programme coupled with the "Air-Sea Battle Doctrine".

China being one of the permanent members of the United Nations Security Council and being a member of the World Trade Organization solidify the fact that China is in a better position to influence global security and global trade. China's thriving economy since its economic reforms in the latter stages of the 1970s and its increasing investments in the U.S., Europe, South Asia, Africa, Central Asia and Australia thus replacing the U.S. and Japan as traditional donors in the international arena further establish China's economic superiority. Moreover extensive use of Chinese soft power and small stick diplomacy are tangible evidence to suggest that China has no appetite for large scale conflicts and wars either with the U.S. or with China's cautious neighbors. In addition to China's contribution to the United Nations Peacekeeping Force China has taken the initiative in establishing security organizations to strengthen international and regional security and peace.

In addition China has been drastically increasing its defence spending each year. Being only second to the U.S. China is one of the five largest military spenders in 2013 according to the Stockholm Peace Research Institute. Housing the world's largest army, a rapidly modernizing

navy with blue water capability, a strong air force with J-20 stealth fighter jets and unmanned aerial vehicles (drones) and a technologically advanced space programme China can definitely aspire to become a superpower. In countering such force the Obama Administration since 2009 has been concentrating on strengthening military ties with its allies in the Asia Pacific region. Given the financial crisis affecting America and cuts on the defence budget, the U.S. military has drawn plans to accelerate rotational deployments rather than promote deployment of permanent bases. For instance deployment of Marines in Japan, the Philippines and Australia are of paramount importance since they have a large symbolic impact. Therefore it is credible to deduce the fact that the driving force behind Washington's "rebalancing" act is China's military modernization.

According to a report published by the Congressional Research Service it is acknowledged however that "China is the U.S.'s second largest trading partner, its third largest export market, and the largest foreign holder of U.S. government debt. It is also the world's second largest economy, with an increasingly influential voice in debates about global economic management". Furthermore according to the report "the Obama Administration can be said to have adopted a two pronged approach to China: reaffirming and strengthening cooperative ties while simultaneously establishing a strong and credible American presence across Asia to encourage Constructive Chinese behavior and to provide confidence to regional leaders who wish to resist potential Chinese regional hegemony". President Xi Jinping when he was the Vice-President opined at a luncheon co-hosted by the U.S-China Business Council on 12 February 2012 that, "China welcomes a constructive role by the United States in promoting peace, stability and prosperity in the Asia-Pacific... at the same time, we hope the United States will respect the interests and concerns of China and other countries in the region".

In such a context the author in this paper attempts to examine the reasons for the U.S. to adopt such a policy towards China since the inception of the Obama Administration in 2009. Is it due to the military rise of China? Is it also because of the possibility of China becoming a hegemonic power which shall dominate the Pacific and the Indian Oceans and hence will not be in the best interests of both the U.S. and its allies in the region? Is it due to America's intentions of remaining the sole superpower while maintaining a unipolar world order? Are Washington's intentions of strengthening relations with China attributable to rapid economic growth made by the latter since its economic reforms? Or is it primarily due to a concoction of all the above reasons? Therefore the objective of the author, based on the answers to the above research questions is to examine U.S.-China relations since 2009 with a greater emphasis on their foreign policies.

THEORETICAL APPROACH

The author intends to view foreign policies of the two countries through the Realist lens. This school of thought facilitates the author to understand the significance of America's Asia Pivot and China's "peaceful rise". It further broadens the author's scope of analyzing Washington-Beijing ties juxtaposed with the principles and norms such as national interest, diplomacy, international law, power and human rights. In addition, other theories such as balance of power, international order, anarchy and integration are also used in arriving at a plausible conclusion. In studying the foreign policies of the U.S. and China, foreign policy theories of leading foreign policy academics and analysts have been incorporated. In this light George Modelski's and Geoffrey Stern's ideas on "foreign policy making" are used comprehensively to evaluate the nexus between the two countries and its impact on America's rebalancing act.

METHODOLOGY

The research will be mainly based on primary sources such as Hansard reports, bilateral and multilateral agreements and Memoranda of Understanding, speeches made by the Heads of States and foreign ministers. Secondary sources such as journal articles, books written on foreign policy orientations of China and the U.S. by foreign policy experts and academics of international relations such as Joseph Nye, John Mearsheimer, Barry Buzan, Rosemary Foot,

Hedley Bull and Kenneth Waltz, "Foreign Policy" and "The Diplomat" magazine articles, web sites of the State Department, the Department of Defence, Ministry of Foreign Affairs of the People's Republic of China, and of American and Chinese think tanks, and of the international media, shall be used extensively in cogently analyzing the hypothesis. Therefore primary and secondary sources shall contribute for quantitative research since an experimental design is not being used by the author. Hence the author shall produce content based analysis through archival research.

CONCLUSION

Anti-China riots have swept across Vietnam over the parking of an off-shore oil rig owned by the China National Offshore Oil Corporation in the disputed waters between China and Vietnam which has in turn led to the evacuation of thousands of Chinese nationals from Vietnam. The Vietnamese Prime Minister has insisted that it is a violation of international law and warned that China has begun to make unpardonable inroads into maritime security in the South East Asian region. Meanwhile the U.S. Justice Department charged five Chinese military hackers for cyber espionage against U.S. corporations and a labour organization for commercial advantage. Moreover the Xinjiang province of China was rocked by brutal terrorist attacks on Chinese citizens. In such an atmosphere it may be credible to deduce the fact that such disputes may drag the U.S. and China into the "Thucydides Trap". Professor Graham Allison of the Kennedy School at Harvard warned both Washington and Beijing not to fall into this mythical trap. If cooperative and diplomatic options exhaust the manifestation of a military confrontation between a rising power and an existing power which is reminiscent of the Peloponnesian war is not a remote possibility.

As the concluding remark the author is of the opinion that States engender fear and suspicion in this anarchical self-help world. While acknowledging Morgenthau's teachings on power China's aims of securing power and maintaining it can be justified in terms of national interests. Containing China conversely may be interpreted as in the best interests of the U.S. Both States however do comprehend that mutual survival is ensured as long as they alienate Mutually Assured Destruction (MAD) from strategic cooperation. Voltaire pontificated that "with great power comes great responsibility". This is the very reason as to why both the U.S. and China must shift their emphasis from orthodox security threats to non-traditional security challenges plaguing the international community such as terrorism, climate change, piracy in the Indian Ocean, arms, drugs and human smuggling since they are vested with such a responsibility. These are some of the areas where a joint effort is required by the parties. Nevertheless the U.S. will remain as the world's super power for at least another decade or two and hence strategic cooperation between the U.S. and China is a must. Further no single super power will succeed in the Indian Ocean region and therefore, India backed by the U.S. and China will remain superpowers in the region for the conceivable future. The rise of the dragon and the demise of a once proud superpower may transform the contemporary unipolar international world order into a bipolar in the foreseeable future.

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VIOLENCE AGAINST WOMEN AS A BASIS FOR ASYLUM: A COMPARATIVE STUDY IN SELECTED COUNTRIES

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INTRODUCTION

The practice of women from countries that have experienced violence against women (VAW) seeking asylum has been customary. Such asylum seekers have increased in recent times. The violence may have been caused by either individuals or the State. Applicants whose asylum claims are based on VAW have faced difficulties in meeting the definition of “refugee” under article 1A(2) of the Convention relating to the Status of Refugees 1951(CSR). Even though it is usually accepted that instances of VAW constitute a grave violation, two interlinking factors have barred victims of VAW from protection under the CSR. These two factors are individual/state dichotomy and gender-related persecution. This paper mainly focuses on gender-related issues in the refugee determination process in Australia, Canada and the United States (US).

Research questions:

1. What are the policies, laws and guidelines available in the selected countries in relation to gender specific refugee claims?
2. What are the pre-requisites that have to be satisfied in claiming refugee status based on VAW?
3. What are the different approaches taken by the States (Policy/Law/Judiciary/) to address VAW by an individual as a ground for refugee claims?
4. To what extent has the International Human Rights (IHR) framework supplemented the lacuna in CSR?

METHODOLOGY & MATERIALS

The tools of data collection are based on primary and secondary sources. This has been primarily through a review of literature. In compiling this data, importance was given to CSR 1951 and its Protocol, which includes international human rights instruments and national laws and policies. Judicial decisions have been used as secondary data. Descriptive and analytical methods are employed in writing this paper. The first part describes the laws and policies that are available in the selected countries while the second part of the paper analyses judicial approaches to this problem through selected case law.

RESULTS AND DISCUSSION

Gender & International Refugee Law

The CSR and 1967 Protocol define as to who is a refugee, their rights and the legal obligations of State parties. Refugee status is granted to asylum seekers based on a well-founded fear of persecution based on five grounds, which are namely ethnicity, religion, nationality, political opinion, or belonging to a particular social group (PSG).

When a female applies seeking refugee status, the host country has discretion to decide whether refugee status could be granted depending on the requirements enshrined under the

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CSR. In gender-based refugee claims, women are required to prove a well-founded fear of 'serious harm', and show that the State has failed to protect her (Seelinger, 2010).

The CSR and the Protocol do not make any specific reference to gender. At present, applications based on gender are mostly considered under the fifth ground in the CSR, which is the "Particular Social Group" (PSG) category in which the host country may consider whether the particular woman who suffered a form of violence belongs to a particular social group. In addition to domestic laws, the UNHCR guidelines (1985, 1991) on gender-related claims, international human rights (IHR) and women rights (WR) play a major role in refugee determination processes. Australia, Canada and the US are signatories to the CSR 1951 and other major IHR conventions.

State Laws and Policies

Canada's *Immigration and Refugee Protection 2001 Act* does not include gender as an independently enumerated ground (Macintosh). A similar position is taken in the Australian *Migration Act 1958* and *Migration Regulation 1994*, and the US *Refugee Act of 1980*. Despite a lack of legal provisions, all these countries have adopted some administrative measures in regard to gender-based refugee claims.

Canada (1993) led the way in the international community by granting protection to women fleeing gender persecution. Canada's leadership was particularly effective in setting an example for the US (1995) and Australia (1996), which issued guidelines shortly thereafter. There are similarities and dissimilarities in these guidelines. According to Susan Kneebone "they are premised upon the vulnerability of women and their lack of opportunity for political participation due to their 'subordinate status' (Kneebone 2005, p, 17) . Further, "they acknowledge the lack of opportunity of refugee women in comparison to men" (Kneebone, 2005, p,17) . "They address the practical ways in which women's claim for asylum can be dealt with sensitivity" (Kneebone 2005, p17) moreover, rape or other domestic forms of violence (DV) and discrimination have been accepted as a Common Ground. All three guidelines have had a salutary influence on the IHR/WR legal framework.

Response of Adjudicative Bodies

In the celebrated *Ward* case in Canada, for first time, courts took the position that refugee claims should be examined taking into consideration the IHR framework. Followed by this case, there were other decisions that took the same position. In Canada, a woman filed a claim (2000) saying that she was subjected to abuse and inhuman treatment by her former husband. In this case, the International Refugee Board accepted that the woman has satisfied the well-founded fear of persecution. In another case, asylum was granted based on the argument that in Somalia there is no legal enactment to address DV and around 50 women die due to DV annually. Hungarian women succeeded in another case based on DV (2001).

Although an Indian woman was living in constant fear as a single, divorced woman, her application for refugee status was not accepted as there was no specific violence committed against her (2001). In another claim based on DV, in Canada asylum was granted and justified on the grounds that there was law, but that law enforcement agencies are ineffective (2002). Asylum for victims of Female Genital Mutilation (FGM), which is custom practiced among some societies in countries like Republic of Ghana and Nigeria, has been granted. Although there was no specific provision for this, asylum has been granted as FGM violates a right to health. A woman from Pakistan was granted asylum based on Forced marriage. In all these cases, the refugee determination is based on the grounds that (a) VAW is a serious harm and (2) the State has failed to protect victims of VAW.

Australia has taken the strict position that family violence does not come under the purview of CSR. Many claims have been rejected on the basis that violence against women by non-State

actors will not be granted asylum. However, the position was changed in the decision of *Khawar* (2002). In this case, the Australian High Court followed the decision of the House of Lords in *Islam and Shah* (1992). The court discussed the two elements of serious harm and the State's obligation to protect women against violence. Followed by this decision, the approach has been changed and women suffering from DV have been granted asylum in many cases.

In *Mendis V MIMA* (2000), a single woman from Sri Lanka successfully claimed asylum demonstrating she was a member of a particular social group, which was namely "single woman vulnerable to sexual aggression and harassment". Although the Refugee Review Tribunal found that her harm as having been personal and motivated by sexual gratification, in the appeal case Branson J held that the Sri Lankan government was not in a position to protect the woman, and therefore asylum was granted.

Khawar expanded the scope of the limitation placed by section 91R of the *Migration Act* 1958. In response to concerns that decisions such as *Khawar*, which had widened the application of the CSR "beyond the intended bounds"². Section 91R was introduced. This made it more difficult to sustain claims for protection on grounds on family violence. The approach taken by the Australia has been criticized by the international community. A Committee recommended that the provision be reviewed "with a view to ensuring it would not exclude from protection people fleeing genital mutilation or domestic violence from which there is little realistic or accessible relief available in their home country."

Although the US has adopted the same policy as Australia in recent years, there has been a notable change (Musalo, 2010). Women seeking asylum on grounds of DV are starting to win their cases with greater regularity. In *Re Fauziya Kasinga* (1996), the first decision in a case involving gender-related persecution, the fundamental issue was whether the practice of FGM can be a basis for asylum under the US immigrant law. Asylum was granted considering that (a) the applicant's case was credible, (b) FGM is a practice of a tribal community that is documented, (c) the applicant is a member of this PSG "consisting of a young woman who have not had FGM" (Musalo 2010) and (d) the applicant has a well-founded fear of persecution as the practice is countrywide.

In *RE RA*, a woman from Gautamala claimed asylum based on DV. The board of immigration appeals characterized that spousal abuse was a private act of violence and asylum was not granted (Musalo, 2010). In *Re SA*, asylum was granted based on DV. In *Shoferav Ins* (2000), asylum was granted for rape. In *Wang v Ashcroft* (2003), asylum was granted based on a forced abortion. In *Gao v Gonzales* (2006), a Chinese woman was granted asylum for forced marriage.

Followed by the *Re SA* decision, asylum guidelines were amended. The amended guidelines aim to "aid in the assessment of claims made by an applicant who has suffered or fear domestic violence" However, adjudicative bodies still assume that DV is a private act. In a recent case in 2012, a Guatemalan woman won her DV-based asylum case after seven years.

CONCLUSION AND RECOMMENDATIONS

The subject of VAW is prevalent in most communities around the world. State parties to IHR instruments require that States protect victims of violence through legal and other measures. However, if they are unwilling/fail to grant such protection, it becomes the responsibility of the international community to extend the required protection. The above study shows that even though the CSR does not make any reference to gender as a ground for asylum, to a

² <http://www.alrc.gov.au/publications/family-violence-and-commonwealth-laws%E2%80%94immigration-law/family-violence-refugee-law> accessed on 30.04.2014

certain extent, all three countries have accepted that VAW by private individuals is a ground for asylum claims. VAW is a serious harm and the failure of a State to protect the victims of VAW has been accepted as a prerequisite for gender-based claims in all three countries.

These three countries have developed guidelines based on IHR/WR Conventions. However, these are mere guidelines And adjudicators are not bound by them. They have discretion, and can assess applications objectively and take decisions. It is to be noted through case law that while adjudicators have extended protection to women under gender-based persecution, they have denied similar protection to others. Since VAW is considered a serious violation and is an impediment to the enjoyment of other rights, the international community should pay attention to the gravity of the situation and take concrete steps to include gender as a ground in the CSR. Further, States should also include gender as a ground for asylum in the law rather than depending on guidelines.

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APPLICATION OF SECULARISM FOR GOOD GOVERNANCE IN SRI LANKAW. M. M. Karunaratne¹¹*Department of Law, Faculty of Arts, University of Peradeniya, Sri Lanka***INTRODUCTION**

After an unpleasant war of 30 years which was waged on ethnic and religious lines, today Sri Lanka too is facing a big religious issue. People from a variety of religions, as well as the priesthoods are fighting to win their own religious rights. The current newscasts show their aggressive behavior even to the international community.

Hence, this article attempts to answer the question: 'Can the Sri Lankan ethnic and religious unrest be cured by using secularism'. However, according to my hypothesis, secularism is the best solution to cure ethnic and religious unrest in Sri Lanka as a country that has various religions and ethnic groups.

METHODOLOGY**DATA COLLECTION**

For the purpose of obtaining effective findings, drawing on the support of both theoretical and practical aspects of the particular area of concern is very essential. Thus, this article can be considered as an outcome of a field survey, as well as a library research.

To obtain general and specialized views on the Sri Lankan religious status quo and the applicability of secularism, the ideas of the general public, legal professionals and the priesthood have been taken into account. The sample was selected randomly as per their religion, ethnicity, occupation, hometown, gender and age. The ideas of the general public were obtained quantitatively by giving questionnaires and the ideas of the legal professionals and the priesthood were taken qualitatively by interviewing them. However, for the convenience of this research, their number was limited to 15 participants.

However, one cannot come to a proper conclusion by depending only on a small field research. Further, the support of theoretical and scholarly ideas is very important in giving better recommendations. Thus, the support of libraries and the internet cannot be disregarded. There, the primary sources like legislations and judgments, as well as secondary sources such as books, dictionaries, encyclopedias, law reviews, journal articles, newspapers have also been referred to.

DATA ANALYSIS

As mentioned in the above paragraphs, referring only to scholarly ideas may not give a practical solution to an issue. Being a social issue, the ideas of the general public have similar validity as experts' ideas. However, in this research, special attention has been paid to include various experiences of the participants involved to enrich their ideas.

In addition, the participants' appreciation of and criticisms of the current Sri Lankan religious condition are analyzed, and their suggestions are taken into account as well. The reasons which they gave to prove their ideas are also considered. Nevertheless, the analysis is conducted by comparing the relevant theoretical ideas which have been published by national

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and international scholars, because sometimes, people's ideas should be shaped for proper governance.

RESULTS AND DISCUSSION

In a democratic society, the ultimate purpose of governance is to establish a peaceful society which honours human dignity. To achieve that purpose, the significant role of the law cannot be disregarded. However, as many jurisprudential schools like the natural law school, sociological school, etc. point out, the law only is not sufficient for good governance. Accordingly, the whole world has recognized the validity of religion as a mechanism of social control, because unlike the law, religion is much closer to people as a part of their lives over a long time. Thus, the relationship between state and religion is very important.

Nonetheless, if the same concept of religion which purports to shape human behavior creates a disturbance and fighting in a society, the government should take all measures to suppress such incidents to achieve the aforementioned real purpose of the law. It is very important, because though religion teaches to develop internal continence in human life, it has now been used to fulfill people's natural desire to separate from each other. Thus, as a major social control mechanism, the law should not follow a lethargic policy on religion.

As mentioned in *Brown v. Board of Education*, the existence of separation halts the protection of people's right to equality. After 53 years of at judgment, US people selected an African American person as the leader of the whole country, but it is doubtless that Sri Lanka would have no non-Buddhist person as her president.

In India, though the Constitution did not recognize the country as a secularist state, it treated all religious and ethnic groups as equal. However, the current India can be taken as a secular state, because its basic structural doctrine recognizes secularism. That movement can be taken as the main reason in protecting the brotherhood among people though India has the highest ethnic and religious diversity in the world.

However, the Sri Lankan situation can be taken as the reverse of the Indian situation. Though Sri Lankan law was developed secularly in the colonial era, after independence, it gradually vanished. The ethnic and religious riots which occurred in the post-independent era point out that giving foremost place to Buddhism is also a reason for those unfortunate incidents. One can correctly argue that giving foremost place to Buddhism serves only a nominal value to the freedom of thought, conscience and religion which have been guaranteed under the Sri Lankan Constitution. It undermines the people's right to equality, non-discrimination, as well as the freedom of expression. Thus, the current ethnic and religious unrest of Sri Lanka proves Aristotle's finding: violation of equality and non-discrimination can result in social combat.

Thus, according to my view, as a state which has various religious groups, it is high time to discuss the importance of secularism for Sri Lankan governance in order to protect the fundamental rights of all without discrimination.

CONCLUSION AND RECOMMENDATIONS

By analyzing the findings of this research, the following can be made as solutions to eliminate the existing unfortunate situation.

- Energize Sri Lanka as a Secular State by Amending the Constitution
- Keep religion away from political affairs
- Take measures to implement the law properly
- Policy development
- Take other social / non-legal measures

- Establish public awareness about the importance of secularism
- If necessary, show the pictures of all religious leaders without limiting to one religion in public places which have not been allocated for a particular religion.
- Treat all the priesthood in an equal manner
- Giving the idea of secularism to people's by the educational system

On the whole, it can be concluded that establishing secularism in Sri Lanka is very important to achieve the real purpose of the law. It is also useful to protect people's fundamental rights which have been guaranteed under the Constitution without, discrimination.

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ORGANIZATIONAL MOTIVATION NEED FOR INNOVATION: ROLE OF INTELLECTUAL CAPITAL OF THE TEXTILE AND APPAREL INDUSTRY IN SRI LANKA

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INTRODUCTION

The emergence of the knowledge economy, intense global competition and considerable technological advances have made innovation the central factor contributing to competitiveness. Innovation is diverse and pervasive. It is applicable to every facet of business activity of every enterprise. The importance of innovation to both individual organizations and the economic development of a society have been highlighted in literature. (Huber, 1984) postulated that innovation, and institutionalized experimentation, will take on an added importance in post-industrial organizations, whose environments will be characterized by increasing knowledge, complexity and turbulence. To be able to innovate on a sustained basis, an innovation capability is important, as research has shown that organizations possessing innovation capabilities have a sustained competitive advantage and use it to achieve higher levels of performance (Alvarez & Barney, 2005; Hurley & Hult, 1998).

Today, the intellectual capital is recognized as the most important and vital ingredient for the success of organizations in a competitive environment. The present economy is a knowledge-based economy. The main ingredients of the production-based economy were land, labor, capital and physical assets. However, in a knowledge-based economy intellectual capital (IC) has become more important than physical assets, in the same way that intellectual capital has been recognized as the most important source of competitive advantage of various organizations which lead to increase the organizational performance and a country's economic growth.

Moreover, the textile & apparel sector around the world has grown as a knowledge concentrated sector in dynamic and competitive environment. From the last decade, the textile & apparel sector has been undergoing dramatic changes in both organizational and technological advancement, pushing top management to reformulate their business strategies. In addition, it is indispensable that the employees of the textile & apparel industry learn to employ the intellectual capital to improve their innovation capability and organizational performance in a knowledge-based economy (Wu & Sivalogathanan, 2013).

The textile & apparel industry is very important for the development of Sri Lankan economy. Sri Lanka is a developing country and a small tropical island off the southern tip of India which is situated in South Asia. Today apparel industry has become one of the largest income generating avenues in the country. It has contributed to 52% of the export earnings of Sri Lanka in 2012. In addition, the industry directly employs nearly 390,000 people all over the country. Industry has spread through the country with a number of factories operating on a small, medium, and large scale, in every district of the country. The significant character of this industry is that, 87% young women and educated employees have been employed as

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workforce. The textile and apparel industry, uses low technology and it can be classified as labour intensive industry.

The purpose of this study is to investigate in particular, the role of intellectual capital in enhancing firm's innovation capability to innovate. In any business, Innovation Management, Knowledge management and Intellectual capital will play a significant role. One of the most important driving forces for the competitiveness of a firm as well as of the entire economy is innovation. Innovations can be defined as the successful implementation of creative ideas, tasks, or procedures without any investments in intangible assets. It will not be possible for any company to generate innovative momentum. Therefore, research question is that "To what extent do Intellectual Capital and Organizational motivation influence as a critical success factor on the innovation capability of the firms". We have drawn these ideas from the theoretical approach of the resource based theory, and literature of innovation that focuses on the organization level of analysis. Responding to these challenges, this paper first theoretically elaborates three key dimensions of intellectual capital, namely human capital (HUC), organizational capital (OGC), and social capital (SOC) as independent variables, Innovation capability (INNOC) as a dependent variable, and Organizational motivation defined as a mediating variable. Secondly, based on this framework, key elements of variables are identified. Used are survey data from textile and apparel manufacturing companies in Sri Lankan, this paper empirically examines how intellectual capital elements influence the Innovation capability through organizational motivation.

H1 - Intellectual capital and Motivation of firm has positive and significant influence on innovation capability and organizational performance.

H1a - Organizational motivation will mediate the relationship between Intellectual capital and innovation capability lead to organizational performance

METHODOLOGY

A structured questionnaire based survey having 32 items was used to collect the data from Textile and Apparel Industry in Sri Lanka. The amended version of questionnaires items were used for this study. The amendments were made to ensure that the constructs are relevant to this research in Sri Lankan context. A total of 450 sets of questionnaires were distributed in Sri Lanka. A total of 304 sets of completed questionnaires were received. The response rate was 67% which was considered good. The measurement of questionnaire adopted five-point Likert scale, a score of 1 to 5 was given according to the extent of agreement and disagreement, to test the interaction between the independent variables and the mediating variable, the Baron and Kenny methods and Sobel test were used. The data were screened and cleaned, to ensure the reliability of the instrument, Cronbach Alpha was used. All constructs shown above had the suggested value 0.7. Therefore, on the basis of reliability test it was assumed that the scales used in this research are reliable to capture the constructs. Confirmatory factor analysis (CFA) was further used to verify reliability and validity of the scales. The composite reliability (CR) values for the three constructs ranged from .73 to .94, exceeding the acceptable level (.60) suggested standard, the average variance extracted (AVE) value also exceeded the threshold level (.50) suggested standard. Furthermore, (Table 5.2) shows the descriptive statistics for the variables used in the model estimations. The mean of all average of constructs were near 4 and above.

RESULTS AND DISCUSSION

The following analyses was conducted to demonstrate the validity of intellectual capital measure. First, the dimensionality of this measure was examined by conducting a principle components factor analysis with varimax rotation. The single factor explaining 55% of the variance was obtained and the components of intellectual capital as human capital, social capital, and organizational capital had high factor loading (average loading more than 0.65),

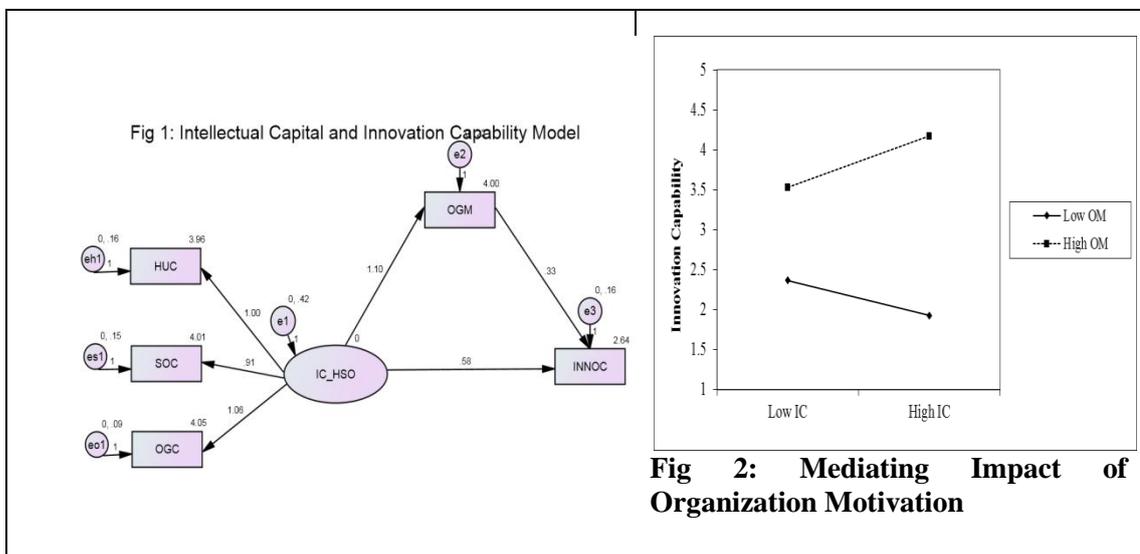
and the Cronbach α value (HUC= 0.869, SOC = 0.865, and OGC = 0.878) respectively higher than standard. The results of CFA were comparable to the estimates and suggested that intellectual capital model provided a modest fit to the data. Despite being significant, chi-square value was little more than three times its degrees of freedom ($\chi^2 = 3.257, df = 87, p < .01$). Furthermore, CFA fit indices exceeded the levels suggested standard (CFI = .931, GFI = .887, NFI = .904, TLI = .916, and RMSEA = .086) (see Figure 5.1; page 181, and Table 5.4; page 182). Further, a one-factor solution with the single factor explaining 43% of the organizational motivation variance emerged, with an average item loading of 0.658. The Cronbach α coefficient value of 0.809, was higher and considered good. The measure of innovation capability explained that a one-factor solution with the single factor explaining 44% of the innovation capability variance emerged, with an average item loading of 0.666. The Cronbach α coefficient value was 0.874.

Table 1: Summary of Correlation Matrix (N=304)

Variables	HUC	SOC	OGC	OGM
SOC	0.691** 0.000	-		
OGC	0.769** 0.000	0.791** 0.000	-	
OGM	0.782** 0.000	0.658** 0.000	0.748** 0.000	-
INNOC	0.688** 0.000	0.689** 0.000	0.751** 0.000	0.797** 0.000

** indicates statistical significance at the 1% level (2-tailed),

The hypothesized model (Figure 1) holds up well when tested against the confirmatory sample of 304 of textile & apparel industry of Sri Lanka. While the X^2 value of 5.609 is statistically significant with 7 degree of freedom, the root mean squared error of approximation is (RMSEA = 0.000, and RMR = 0.004) which suggests a good fit since it is below the critical threshold of 0.08 as suggested by (Browne, Cudeck, Bollen, & Long, 1993). Further, the Normed Fit Index (NFI = 0.997), the Goodness of Fit Index (GFI = 0.995), the Incremental Fit Index (IFI = 1.001), and the Confirmatory Fit Index (CFI = 1.000) are all between 0.99 and 1.0, suggesting that the research model fits the observed data well.



The indirect and direct effects of Intellectual capital on Innovation capability through Organizational motivation were constructed by AMOS standardized parameter estimates for the effects of intellectual capital on organizational motivation and the effects of organizational motivation on innovation capability independent of intellectual capital. Thus, the indirect effects of intellectual capital on innovation capability was perceived as 0.332. Organization motivation has indirect effects of intellectual capital as 0.339. These indirect effects were statistically different from zero, indicating that the intellectual capital indirectly influence on innovation capability through organizational motivation. In mediating model, the results shows that intellectual capital significantly and positively related to the dependent variable ($\beta = 0.43, p < .05$). Thus, Hypothesis H1a was supported based on the original (Baron & Kenny, 1986) procedure. The results of the Sobel test provided further support for the significance of the indirect relationship between intellectual capital and innovation capability through organization motivation in the second model when organization characteristics is moderating the Sobel results shown significantly (Sobel $z = 4.72, p < .05$).

CONCLUSIONS/RECOMMENDATIONS

This study explored three main research themes. First, it explored the direct and indirect effects of intellectual capital on innovation capability. Second, it explored the mediating effects of organization motivation on innovation capability in the textile & apparel industry of the Sri Lanka. The findings of the research concerning the direct effects of intellectual capital on innovation capability within the textile & apparel industry showed that certain intellectual capital variables, namely human capital, social capital, and organizational capital were positively linked with innovation capability. Concerning the indirect effects, the research found that intellectual capital had an effect on innovation capability through organization motivation. This finding highlights that when the textile & apparel industry creates an organization motivation and innovation-oriented environment, that facilitates better firm performance from better innovation. This research has provided several significant contributions to the theory, research and practice in the fields of intellectual capital, knowledge management, and innovation capability. Furthermore, these findings should be beneficial for practitioners, policy-makers, advisors and higher education institutions when providing business advice and training for textile & apparel industry and export firms.

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WEDDING BANQUETS IN FIVE STAR HOTELS IN COLOMBO: IMPACT OF QUALITY DIMENSIONS AND PRICE ON CUSTOMER SATISFACTION

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INTRODUCTION

Wedding banquet is playing a premier role in the hotel industry and has contributed to the hotel revenue approximately more than 75% within one year (Asian Hotels Association Annual Report 2011/12). A wedding banquet is a party held after completion of a marriage ceremony showing hospitality for invitees at the wedding. After a wedding, consumer satisfaction is important as it is of the most critical marketing priorities because it is generally assumed to be a significant determinant of repeat sales, positive word-of-mouth, and customer loyalty. Parker C. and Mathew B.P. (2001) expressed that there are two basic definitional approaches of the concept of customer satisfaction. The first approach defines satisfaction as a process and the second approach defines satisfaction as an outcome of a consumption experience. These two approaches are complementary, as often one depends on the other. Hence, different attributes are required for selection of wedding location by the host. According to Kisang R. and Heesup H. (2009) quality of food, quality of staff service, and physical environment strongly affect customer satisfaction in restaurants and wedding banquets in the Midwestern State of the USA and they found that the quality of food is the most stimulus variable for customer satisfaction. But, Chloe K.H. Lau et al., (2009) stated that price has been considered a significant component in increasing customer satisfaction without actually influencing customer perceptions of service quality in Asian countries. Hence, identifying the gap between both researchers, this paper sets out to examine the relationships between three determinants of quality dimensions (quality of food, quality of service, and physical environment) and customer satisfaction, identify existing situation of quality dimensions and investigating the combined influences of the quality of food, service, and physical environment on customer satisfaction. This study will facilitate *banquets managers* and policy makers for their decision making process and enhance their subject knowledge on the wedding banquets industry.

Hypothesis

- H₀ There is no relationship between quality dimensions and customer satisfaction.
H_a There is a positive relationship between quality dimensions and customer satisfaction.
H₀ There is no relationship between price and customer satisfaction.
H_b There is a positive relationship between price and customer satisfaction.

METHODOLOGY

The study has focused on the relationship of quality dimensions, price and customer satisfaction of wedding banquets with special reference to six (06) five star hotels in the Colombo district. Reviewing literature on customer satisfaction was identified as dependent variable while taking quality of food, quality of staff service, physical environment and price as independent variables for the study. The population of research were married couples who celebrated their wedding function at five star hotels in the Colombo district from May to December 2013 as people take their wedding in this particular time duration. Total number of wedding functions in six five star hotels was 637. Non proportionate stratified sampling technique was used to select a sample of 100 respondents from selected hotels, because they had conducted total wedding functions in different numbers. Both primary and secondary data were collected and self-administered questionnaires were used to gather primary data. Cronbach's alpha Reliability Test was used to measure internal consistency and the Alpha

coefficient for the 18 items is .901, suggesting that the items have excellent internal consistency.

RESULTS AND DISCUSSION

Primary data was analyzed using descriptive statistics, correlation coefficients and multiple regression analysis with Mini tab 15 software. Descriptive analysis was used to analyze the demographic factors including name of the hotel, age distribution and level of income. Most of wedding banquet were held at the Cinnamon Grand Hotel (20 percent) and the Galadari Hotel (13 percent) only attracted a few functions. The highest percentage of hosts of wedding was represented by 22 - 34 year age group, which was 98 percent. Both under 22 and 35-44 age groups were represented only 2 percent. 73 percent of hosts of weddings had over 750,000 annual income and 27 percent were represented range of 50,000-750,000.

Mean value of the quality dimensions comprise within the range of between 1 to 2.5 and the mode of 1.5 implies that almost all the hosts of wedding agreed with the existing level of quality dimensions. 1.5050 illustrated all the hosts of wedding agreed with quality of food which they received from the hotel. Majority of them agreed with the quality of food which was represented by mode 1.25. Furthermore, it explained that the hosts had felt that they received good menu variety, cleanliness, nutrition, tasty food. Hosts of wedding agreed with the current situation of quality of staff service of the hotel since its mean value was 1.8850 and mode was 1.75. When considering quality of physical environment, its mean was 1.6950, mode was 1.5, standard deviation was 0.5681 and coefficient of variation was 33.51. It implies that hosts of wedding had agreed with the existing situation of quality of physical environment. Hosts of wedding had different attitude towards physical environment, which was represented by the 33.51 coefficient of variation. The mean with respect to overall customer satisfaction of hosts was 1.8900. That implies that almost all the hosts had agreed with existing level of overall customer satisfaction since mean value was less than 2.5.

Correlation analysis is measured by calculating the Pearson correlation coefficient. Correlation analysis shows the extent to which quality dimensions, price and customer satisfaction variables vary together including the strength and direction of their relationship. Correlation between independent variable quality dimensions and dependent variable customer satisfaction 0.665, and correlation between independent variable price and dependent variable customer satisfaction 0.578 imply that there were moderate positive relationship between quality dimensions and customer satisfaction and a moderate positive relationship between price and customer satisfaction. Moreover a person correlation coefficient was approximate to 0.7. Furthermore p-value of 0.000 emphasizes that there was a significant relationship between independent and dependent variables. Positive relationship illustrates increment of level of price guide to increase the customer satisfaction. For the quality of food dimension, it denoted a 0.582 value of correlation and for the quality of staff service dimension, there was a 0.601 correlation which shows moderate positive relationships between dependent variable and independent variable. The highest correlation coefficient was 0.659, between quality of physical environment and customer satisfaction showing a moderate positive relationship between independent quality of physical environment dimension and customer satisfaction. P-value of 0.000 implies that there were significant relationships between independent dimensions and dependent dimension at 0.05 level of significant.

Multiple linear regression analysis including R square, adjusted R square value, predicted R square value and standard error of estimate value was used for study linear relationships between quality dimensions, price and customer satisfaction. The R square value for the model was 0.610 which represent 61 percent of variation in customer satisfaction dependent variable was explained by quality dimensions and price.

Figure	Value
Standard Error of Estimate	0.393900
R Square	0.610
Adjusted R Square	0.602
Predicted R Square	0.584

Source: field survey 2013

Therefore the model was appropriate and significantly predicts the customer satisfaction by independent variables.

Predictor	β Coefficients	Standard Error	P
Constant	0.0428	0.1626	0.793
Overall service Quality	0.8307	0.1059	0.000
Price	0.18528	0.08718	0.036

All the beta coefficient values represent positive values. Hence, there was a positive relationship between quality dimensions and price and customer satisfaction. When considering quality dimensions variable, the β coefficient of 0.8307 indicates that when quality dimensions was increased by one unit while other variables remain constant, customer satisfaction was increased by 0.8307 units. Furthermore, quality dimensions contributed significantly to the model since p-value of 0.000 which was less than 0.05 level of significant. Therefore null hypothesis H_0 was rejected and alternative hypothesis H_a was accepted. Following equation had identified for multiple linear regression analysis,

$$CS = -0.159 + 0.251 QF + 0.374 QS + 0.235 QPE + 0.211P + \delta$$

Where, CS= Customer Satisfaction, β_0 = Intercept of the equation, QF = Quality of Food, QS = Quality of Service, QPE = Quality of Physical Environment, P = Price

Predictor	β Coefficients	Standard Error	P
Constant	-0.1586	0.1474	0.285
Quality of food	0.2507	0.1114	0.027
Quality of Service	0.3741	0.1112	0.001
Quality of Physical Environment	0.2354	0.1050	0.028
Price	0.21120	0.07824	0.008

Source: filed survey 2013

(β_0) was -0.1586 which illustrate that while quality of food, quality of staff service, quality of physical environment and price equal to zero, customer satisfaction was -0.1586. P- Value of constant was 0.285 which statistically not significant at 0.05 level of significant. In addition, all the beta coefficient values represent positive values. Hence, there was a positive relationship between quality of food, quality of staff service, quality of physical environment and price and customer satisfaction. According to above analysis, quality of food, quality of staff service, quality of physical environment and price were highly significant for the model as its p-values were less than 0.05. Among these four variables customer satisfaction held on impact on quality of staff service and quality of food, its coefficients are 0.3741 and 0.25683 respectively.

CONCLUSION AND RECOMMENDATIONS

According to the findings of the study, there is a moderate positive relationship between the overall service quality dimensions, price and customer satisfaction as p-value of 0.000 is less than 0.05 level and Pearson correlation is 0.665. Respondents for the study agreed with existing conditions of quality dimensions (quality of food, quality of service, and physical environment), price and customer satisfaction of wedding banquets in five star hotel in the Colombo district. Overall service quality and price have a significant impact on customer satisfaction and customer satisfaction is highly influenced by variable of overall service quality than price in wedding banquets in five star hotels in Colombo district. Quality of food, quality of staff service, and physical environment and price have a significant significantly impact on customer satisfaction. Customer satisfaction is highly influenced by quality of staff service in wedding banquets in five star hotels in the Colombo District.

Since the study found that the quality of staff service is a key driver of customer satisfaction in the wedding banquets sector in the Colombo district, it is recommended that the management of hotels should clearly consider service strategies in improving upon its satisfaction of hosts of wedding. Training programs to develop skills and competencies of service staff and brainstorming secessions should be conducted and it will indirectly influence the performance of the hotels. Furthermore, the management should organize career guidance programs to develop their career and enhance self-respect, self-confidence and self-image of hotel staff.

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Banquet Managers at the Kingsbury hotel, Galadari hotel, Cinnamon Lakeside Hotel, Hilton Colombo, Cinnamon Grand Hotel and Taj Samudra Hotel in Colombo.

All respondents for the study.

AN ECONOMETRIC ANALYSIS OF HOUSEHOLD DEMAND FOR MAJOR PROTEIN SOURCES IN SRI LANKA: THE ALMOST IDEAL DEMAND SYSTEM WITH INFREQUENCY OF PURCHASE

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INTRODUCTION

Food demand patterns of a particular country play a vital role in developing policies. They assist to improve the nutritional status of individuals and households through identifying the most appropriate policy interventions. They help the government in which food subsidy strategies should be implemented. Moreover, the knowledge of food consumption behaviour is essential for sectoral and macroeconomic policy analysis (Weliwita *et al.* 2003).

The estimation of price and income elasticities of food is the key to the analysis of food demand behaviour. According to existing literature, primary attention has been paid in the past to the estimation of food demand elasticities in developed countries (Weliwita *et al.* 2003). Even though numerous studies have been published about developing countries, a paucity of studies is found on food demand behaviour of Sri Lankans in published literature.

However, due to urbanization and changes in lifestyle patterns, Sri Lanka is experiencing a nutritional transition. Recent studies signify that 18.3% of total mortality and 16.7% of hospital expenditure in Sri Lanka account for diet-related chronic diseases, whereas studies on the subject of dietary choices are rather scarce in the Sri Lankan context (Jayawardena *et al.* 2012).

Out of all nutrients that the body needs to be healthy and to function efficiently, protein is the main building block of all cells of the body. It is also a source of calories and is needed to improve immune response. Protein deficiency affects all organs and is of particular concern during growth and development. Hence, an adequate intake of high quality protein is essential for good health (Ministry of Health 2011). Yet, Protein Energy Malnutrition (PEM) has been accounted for one of the leading contributory factors to morbidity and mortality in Sri Lanka. Therefore, this study aims to present price and expenditure elasticities in order to discover the consumption behaviour of major protein sources by incorporating an economic framework to households in Sri Lanka. Moreover, this intends to determine the impact of demographic factors that influence dietary choices in terms of protein sources.

METHODOLOGY

The Almost Ideal Demand System (AIDS) proposed by Deaton and Muellbauer (1980) was employed in this study. Data for the analysis were taken from the Household Income and Expenditure Survey (HIES) 2006/07, which was conducted by the Department of Census and Statistics, Sri Lanka. The completed sample size was 18,544 households.

The weekly consumption of 52 food items was selected according to the major protein sources (pulses, meat, fish and eggs; $n = 4$), which have been recommended by the Ministry of Health (2011). To circumvent infrequent consumption problems that are observed in most

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households, we used a two-stage estimation; in the first stage, purchase decision was modeled using a probit model and the Inverse Mills Ratios (IMR) obtained were used in the subsequent AIDS as an instrumental variable to correct bias.

The estimated augmented AIDS model with socio-demographic variables is:

$$W_i = \alpha_i + \beta_i \ln\left(\frac{X}{P^*}\right) + \sum_j \gamma_{ij} \ln(P_j) + \sum_k \zeta_{ik} Z_k + \omega_i \Phi_i + \varepsilon_i \quad (1)$$

Where, W_i = budget share of i^{th} protein source; X = the total expenditure on all protein sources per household; P^* = price index; P_j = prices of the j^{th} protein sources; Z_k is the matrix of demographic or socio-economic variables; ε_i = error term of i^{th} protein source (Bett *et al.* 2012).

To conform to demand theory, adding up (2), homogeneity (3) and symmetry (4) restrictions were imposed on the equation (1):

$$\sum_i \alpha_i = 1, \sum_i \beta_i = 0, \sum_i \gamma_{ij} = 0, \sum_k \zeta_{ik} = 0, \sum_i \omega_i = 0 \quad j = 1, \dots, n. \quad (2)$$

$$\sum_j \gamma_{ij} = 0, i = 1, \dots, n. \quad (3)$$

$$\gamma_{ij} = \gamma_{ji}, j = 1, \dots, n. \quad (4)$$

To avoid nonlinearity, P^* in the equation (1) was estimated as the Stone price index:

$$\ln(P^*) = \sum_i \bar{W}_i \ln(P_i) \quad (5)$$

Where, \bar{W}_i denotes the mean budget share of i^{th} protein source (Bett *et al.* 2012).

Elasticities

Marshallian price elasticities [equation (6)] and expenditure elasticity [equation (7)] of i^{th} protein source were calculated as:

$$\varepsilon_{ij} = -\delta_{ij} + \frac{\{\gamma_{ij} - \beta_i \bar{W}_j\}}{\bar{W}_i} \quad (6)$$

Where, δ_{ij} = Kronecker delta, which is equal to one for $i = j$ and zero for $i \neq j$ (Bett *et al.* 2012).

$$\eta_i = 1 + \frac{\beta_i}{\bar{W}_i} \quad (7)$$

A Seemingly Unrelated Regression (SUR) technique was employed to avoid the possible correlation of errors of each equation. The estimation was carried out by the use of Stata 11.2, under the constrained Iterated SUR procedure.

RESULTS AND DISCUSSION

Usually, the model significance in SUR models is checked through Chi-square tests. Here, Chi-squares for all equations were significant at 1% level. The significant coefficients of IMRs at 1% level imply that the ignorance of zero budget shares when estimating the system would generate biased and inconsistent parameter estimates. Own price coefficients of pulses and meat were significant at 5% level, while parameters of real expenditure were significant for all protein sources except eggs (Table 1).

The demographic and socio-economic variables in Table 1 highlight that the urban community spends less on pulses compared to the rural community. This may be because most people in urban areas are engaged in tight daily routines and, thus, they will be more likely to consume prepared or instant foods. Conversely, among the estate community, dietary choices for protein sources will be significantly varied among pulses, meat and fish. With relative to the

rural areas, the higher prices of fish in estate regions due to unavailability may lead to a lower consumption of fish and a higher consumption of pulses and meat.

Implying the religious beliefs and cultural habits influence dietary choices, compared to Hindus, Muslims and Catholics/ Christians will have a significant positive effect on the budget allocations on meat and have a negative impact on pulses. Also, it can be seen that in the budget shares of meat and fish, Buddhists allocate more for fish than meat.

Table 1 – Parameter estimates of the AIDS

Variables	Pulses	Meat	Fish	Eggs
Pulses price	0.0901*	-0.0223*	-0.0520*	-0.016
Meat price	-0.0223*	-0.0543*	0.0706*	0.006
Fish price	-0.0520*	0.0706*	0.004	-0.023
Eggs price	-0.0158*	0.006	-0.0226*	0.032
Real income	-0.156*	0.141*	0.0672*	-0.052
IMR	-0.0735*	0.0403*	-0.010	0.043
Constant	1.432*	-0.947*	0.196*	0.319
Urban sector	-0.0133*	0.007	0.008	-0.001
Estate sector	0.0680*	0.0156*	-0.0939*	0.010
Buddhist	-0.004	-0.0554*	0.0546*	0.005
Islam	-0.0372*	0.189*	-0.105*	-0.047
Catholic/Christian	-0.0372*	0.0579*	0.004	-0.025
Household size	0.0193*	-0.0114*	-0.0128*	0.005
Gender of the head	0.011	-0.015	0.009	-0.005
Education level of the head	0.000	0.002	-0.002	0.001
Employment status of the head	-0.005	0.007	-0.007	0.004
Education level of the spouse	0.000	0.001	-0.00169*	0.001
Employment status of the spouse	0.013	0.013	-0.024	-0.002
Presence of children	-0.0198*	0.003	0.0163*	0.000
Presence of heart diseases	0.003	-0.008	0.007	-0.001
Presence of blood pressure	0.006	-0.0125*	0.009	-0.003
Presence of diabetes	0.005	0.011	-0.013	-0.003
Owned land extent	0.006	0.003	-0.00850*	0.000

*significant at 5% level.

It is evident that an increase in household size will boost the budget shares of pulses, while reducing budget allocations for expensive fish and meat because when a family has more members, they tend to satisfy their needs by eliminating expensive goods. This suggests that households with more members will choose pulses to fulfill their protein requirement.

Furthermore, the gender of the household head, and the education level and employment status of the head and spouse did not significantly contribute to any budget shares. Since fish is a wholesome food that helps to form and maintain bones and teeth and to reduce the risk and incidence of rickets in children, the presence of children in a household significantly influences budget shares for fish positively and for pulses negatively. As meat is rich in cholesterol and fat, the presence of blood pressure was significant for a negative budget share for meat, while the presence of heart diseases and diabetes were not critical for any shares.

The significant negative influence of owned land extent on fish budget shares inferred that when people have more lands to cultivate, they subsist from their own cultivations. However,

there was no significant contribution for the shares of pulses, meat and eggs from the owned land extent.

Own price elasticities of all protein sources carry a negative sign, as expected. The values denoted that meat and fish were more responsive to their price changes, while pulses and eggs were less responsive. This implies that in case of a price increase in food commodities, more would be allocated to pulses and eggs. Cross price elasticities suggest that protein sources are more of complements than they are substitutes (Table 2).

The positive values of expenditure elasticities of all protein sources highlighted that all of them are normal and, thus, an increase in income would lead to higher consumption. Results indicated that out of all protein sources, pulses and eggs can be considered as necessities, which imply that they play an important role in household diets, and meat and fish are luxuries, which emphasize that higher income households spend proportionately more on them.

Table 2 - Elasticity estimations

ϵ_{ij} - Own price elasticities	Pulses	Meat	Fish	Eggs
Pulses	-0.448	-0.417	-0.114	-0.082
Meat	-0.009	-1.560	0.105	0.245
Fish	0.177	-0.096	-1.060	0.146
Eggs	-0.034	-0.010	-0.044	-0.323
η_i - Expenditure elasticities	0.313	2.080	1.110	0.015

Note: ϵ_{ij} : diagonal values = own price elasticities, off diagonal values = cross price elasticities

CONCLUSIONS/RECOMMENDATIONS

This study revealed that the sector (urban, rural and estate), religion, household size, presence of children, owned land extent and the presence of blood pressure has a significant impact on dietary choices in terms of protein sources. Moreover, the household income is likely to have a higher impact on the consumption of meat and fish. Conversely, the consumption of pulses and eggs can be mostly affected by their own price changes. Consequently, attention should be paid to these issues for any food policy, to be effective.

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**ASSESSING THE SYSTEMS APPLICATIONS AND PRODUCT IN
MANUFACTURING (SAP) SYSTEM AS A SOLUTION FOR ENTERPRISES
RESOURCE PLANNING (ERP) TO CATER LEAN INITIATIVES:
AN EMPIRICAL STUDY AT MAS HOLDINGS**

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INTRODUCTION

Enterprise Resource Planning (ERP) systems are highly complex information systems. Therefore it is essential to get an indication of using the Lean concept in formulating the ERP. The implementation of these systems is a difficult and high cost proposition that places tremendous demands on the industry. Systems Applications and Product in manufacturing (SAP) is currently using ERP system at MAS Holdings. The objective of this study is to identify the gaps of an existing SAP system as an ERP to cater to lean initiatives to improve production efficiency based on user satisfactions and training.

RESEARCH METHODOLOGY

Information and opinion would be gathered on the status of a single piece flow as a pull production system in the lean process. It is then assessed as to what level standardization has been carried out and the level of ERP involvement expected by the business. The capability of the current implementation of the ERP will be assessed too, so that a gap could be identified. It is planned to address these gaps via the model that is proposed. Understanding the roadmap set for the lean process at the organization, the existing ERP solution is analyzed module-wise to identify the extent to which lean requirements are satisfied by the ERP. The feedback received from the interviewees, the expert opinions obtained and questionnaires would be used to create a matrix where Lean meets ERP. The ideas, concerns and proposals put forward by the interviewees would be used to come up with a simple questionnaire that could be used to obtain reconfirmation from interviewees and veterans/experts.

Finally, it is the intention of this study to make an effort to coincide the ERP software life cycle with the roadmap set for the lean journey, and thus, identify the cornerstones of the ERP system that needs to be configured for a long-term plan. A short-term strategy will be discussed to accommodate the lean initiative resulting out of the mini projects. Both the above strategies will be considered in formulating a model for implementing ERP with the Lean philosophy.

SAP was assessed as ERP by using the CSFs across the stages of the ERP implementation process using the responses from 50 respondents who are in the process of completing SAP implementations. The sample comprised the SAP team members, SAP Business consultants and a few of the SAP consultants at Attune Consulting, which is the International Consultancy arm of MAS Holdings, and data was collected via structured questionnaires. Expert opinions that have been published, previous researches and a questionnaire completed by MAS have been used to gather data for analysis.

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RESULTS AND DISCUSSION

Analysis of the SAP as ERP to cater to a Lean Initiative: Somers & Nelson (2001) has clearly suggested a list of Critical Success Factors (CSF) by using mean values. Therefore, these CSFs were taken as test values (as shown in Table 2). Accordingly, the following hypothesis was tested for each CSF in implementing SAP as the ERP to cater to Lean initiatives. Then the weighted mean score value and tested mean score value for the all success factors were derived to test the hypothesis of whether the SAP as the ERP is sufficiently capable of catering to Lean initiatives.

H₁₀: SAP as the ERP is not capable enough to cater to Lean initiatives

H_{1a}: SAP as the ERP is capable enough to cater to Lean initiatives

Prior to the statistical analysis all twenty two items were tested for their reliability (Table 1). As such, the Cronbach's Alpha was calculated to measure the reliability of all critical factors. It is observed that the reliability coefficients are all above 0.7 for all critical factors. Therefore, all twenty two CSFs were deemed to be reliable according to Nunnally (1978). Then, as the next step of testing the hypothesis, the sample was tested for its distribution. The Kolmogorov-Smirnov Test was performed to test the distribution of the critical success factors. It is observed that the derived p-value for the test is higher than 5% for all factors, implying normal distributions. As such, one sample t-test is used as the tool of comparing means. One tailed test is used as a rejection region confined to only one tail of the sampling distribution. The test is performed at 5% confidence level.

Table 1. Result of reliability analysis for CSF

Critical success factors	α Value	Critical success factor	α Value
Top management support	0.721	Minimal customization	0.751
Dedicated recourses	0.710	Management of expectations	0.761
Project team competence	0.783	Architecture choices	0.706
Use of steering committee	0.745	Project champion	0.712
Interdepartmental cooperation	0.701	Change management	0.746
User training on software	0.756	Vendor support	0.743
Clear goals and objectives	0.733	Partnership with vendor	0.723
Education on new business process	0.710	Careful package selection	0.734
Project management	0.722	Use of vendor's tools	0.714
Business process Reengineering	0.788	Data analysis & conversion	0.764
Interdepartmental communication	0.741	Use of consultants	0.723

Among the twenty two critical factors, the p-value for the project champion/leader, user training on software, vendor/customer partnerships, careful selection of the appropriate package, the use of consultants, defining the architecture, project team competence and ongoing vendor support are significant. Therefore, we reject the null hypothesis and accept the alternative hypothesis. Accordingly, the critical factors, namely the project champion/leader, user training on software, vendor/customer partnerships, careful selection of the appropriate package, the use of consultants, defining the architecture, project team competence and ongoing vendor support at MAS holdings are sufficiently capable of using SAP as the ERP to cater to Lean initiatives.

Table 2. Results of the t-test perform on CSF

Critical success factors	Test Mean Value	Derived Mean	P Value	SD	Capability of SAP
Top management support	4.29	2.62	0.061	1.502	Not
Dedicated recourses	3.81	3.64	0.158	1.352	Not
Project team competence	4.20	3.82	0.001	0.785	Capable
Use of steering committee	3.79	2.85	0.077	1.643	Not
Interdepartmental cooperation	4.19	3.71	0.180	1.510	Not

User training on software	3.79	4.20	0.000	1.056	Capable
Clear goals and objectives	4.15	2.99	0.063	1.140	Not
Education on new business process	3.76	2.84	0.084	0.987	Not
Project management	4.13	3.10	0.142	1.431	Not
Business process Reengineering	3.68	2.04	0.091	1.541	Not
Interdepartmental communication	4.09	3.01	0.078	1.014	Not
Minimal customization	3.68	2.98	0.110	1.472	Not
Management of expectations	4.06	2.54	0.124	1.357	Not
Architecture choices	3.44	3.30	0.002	0.891	Capable
Project champion	4.03	4.13	0.000	1.056	Capable
Change management	3.43	2.17	0.067	1.115	Not
Vendor support	4.03	4.12	0.000	1.430	Capable
Partnership with vendor	3.39	3.45	0.001	0.783	Capable
Careful package selection	3.89	4.01	0.000	1.642	Capable
Use of vendor's tools	3.15	3.05	0.101	1.840	Not
Data analysis & conversion	3.83	2.75	0.185	1.032	Not
Use of consultants	2.90	3.01	0.002	0.982	Capable

Among the twenty two critical factors, the p-value for top management support, management of expectations, use of vendors' development tools, steering committee, project management, minimal customizations, dedicated resources, data analysis and conversion, clear goals and objectives, business process reengineering, education on new business processes, change management, interdepartmental communication and cooperation are not significant. Therefore, there is insufficient evidence to reject the null hypothesis. Accordingly, the critical factors, which are namely top management support, management of expectations, use of vendors' development tools, steering committee, project management, minimal customizations, dedicated resources, data analysis and conversion, clear goals and objectives, business process reengineering, change management, education on new business processes, interdepartmental communication and cooperation, at MAS holdings are insufficiently capable of using SAP as the ERP to cater to initiatives.

Table3. Critical Success Factor Analysis

Critical success factors	Derived	Test Mean	Critical success factor	Derived	Test Mean
Top management support	2.62	4.29	Minimal customization	2.98	3.68
Dedicated recourses	3.64	3.81	Management of expectations	2.54	4.06
Project team competence	3.82	4.20	Architecture choices	3.30	3.44
Use of steering committee	2.85	3.79	Project champion	4.13	4.03
Interdepartmental cooperation	3.71	4.19	Change management	2.17	3.43
User training on software	4.20	3.79	Vendor support	4.12	4.03
Clear goals and objectives	2.99	4.15	Partnership with vendor	3.45	3.39
Education on new business process	2.84	3.76	Careful package selection	4.01	3.89
Project management	3.10	4.13	Use of vendor's tools	3.05	3.15
Business process Reengineering	2.04	3.68	Data analysis & conversion	2.75	3.83
Interdepartmental communication	3.01	4.09	Use of consultants	3.01	2.90

Weighted Mean score for the CSF = 3.805

Tested Mean score for the CSF = 3.197

The weighted mean score value is greater than the tested mean score value for critical success factors as a whole. There is insufficient evidence to reject the null hypothesis. Therefore, the study concludes that the SAP as the ERP is insufficiently capable to cater to Lean initiatives.

Analysis of the Given User Training Period: This part of the analysis was undertaken to identify whether users are satisfied on a given training period. Sample users were asked to state the training hours that they had required and the hours they were given. The collected data was used to test the following hypothesis:

- H_0 : Users are not satisfied with the given training (Given period < Expected period)
 H_1 : Users are satisfied given training (Given period \geq Expected period)

Before analysis, the Kolmogorov-Smirnov Test was performed to test whether the expected and given training hours follow a normal distribution. It is observed that the p-value is less than 5% for all variables, implying non-normal distributions. Accordingly, thenon-parametric test is used to test the hypothesis. Among the sign and wilcoxon signed-rank test, the Wilcoxon test is performed as it considers information on both the sign of the differences and the magnitude of the difference between pairs.

Table4. Analysis of the Given and Expected Training Period

Variables	Ranks	N	Mean Rank	Sum of Rank
Expected-Given	Negative Ranks	16(a)	3.14	50.24
	Positive Ranks	19(b)	4.59	87.21
	Ties	0(c)		
	Total			
	Expected-Given	a)	Based on negative ranks	
Z	-1.484(a)	b)	Wilcoxn Signed Rank Test	
Sig level	.138			

In these data, 16 cases had negative differences where their sum equaled to 50.24. On the other hand, there were 19 positive cases with the sum of 87.21. Z is the standardized measure of the distance between the rank sum of the negative group and its expected value. According to the significant level, there is insufficient evidence to reject the null hypothesis. Therefore, the study concludes that users are not satisfied with the given training hours.

CONCLUSION

CSF analysis shows that the weighted mean score value (3.805) is greater than the tested mean score value (3.197). Therefore, the study concludes that the SAP as the ERP is not sufficiently capable of catering to Lean initiatives. It is concluded that ERP capabilities are not in a position to fulfill the lean concept at MAS Holdings and results advice management on how best to utilize their limited resources to align the Lean concept in preparing the ERP. According to the wilcoxon signed-rank test, the study concludes that users are not satisfied with the given training. Considering the results and conclusions drawn, based on expert opinions and findings from interviews and questionnaires, a number of key performance areas have been defined to lay out a proposed road map for a lean ERP implementation.

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ARIMA MODELS ON FORECASTING STOCK RETURNS

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INTRODUCTION

Profit maximization is the base line objective of many investments. Therefore, predictability of share returns in a secondary market is of immense importance to investors. The most popular forecasting model, which is known as the Capital asset pricing model (CAPM), has been used for predictions in the Sri Lankan share market. However, the forecasting ability of CAPM has been debated over the last decades. Nimal (1997), Samarakoon (1997) and Konarasinghe and Abeynayake (2014) have given evidence of the inability of CAPM in the Colombo Stock Exchange (CSE). Therefore, the Sri Lankan stock market is in need of finding suitable techniques for forecasting share returns.

Box-Jenkins (1976) methodology or the ARIMA methodology has also been widely tested for forecasting share returns, but such studies have been limited in the Sri Lankan context. Further, previous studies have not given enough evidence for the success of ARIMA models in forecasting returns of individual companies or business sectors of the CSE.

The stock market is a population that contains a large number of subsets (sectors). These subsets are defined in a way that they are mutually exclusive, and the elements of these subsets (listed companies of these sectors) are homogeneous in terms of their nature of business. As such, there may be some similarities in their market performances and similar forecasting techniques may be successful, sector-wise. In view of these, the objective of the current study was to test ARIMA models on the forecasting of the returns of individual companies in one of the selected sectors of the CSE.

METHODOLOGY

The ARIMA model is a General Linear Process, which is given by the following formula:

$$\phi_p(B)\Delta^d Y_t = \theta_q(B)\varepsilon_t \quad (1)$$

Where, Y_t = present value, ε_t : present error, B = backshift operator.

The CSE has 20 business sectors or 20 subsets. This study was based on the Plantation Sector (PLANT) of the Colombo Stock Exchange (CSE). A random sample of three companies was selected from the eighteen companies in the sector. They were: Agalawatte Plantation Limited (AGAL), Bogawantalawa Tea Estate Limited (BOGAW) and Watawala Plantations PLC (WATA). Daily closing share price data from year 1998 to 2011 and the monthly sector indices of PLANT were obtained from the CSE data library in 2011.

The monthly average returns from January 1998 to December 2008 were used for the ARIMA model fitting, and monthly average returns of January 2009 to September 2011 were used for model verification. The Auto Correlation Functions (ACF) and the Partial Autocorrelation

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Functions (PACF) were obtained to test the stationary of the series. Modified Box-Pierce (Ljung-Box) test was used to test residual auto correlations, and the Anderson Darling test was used to test the normality of residuals. The best fitting model for each company was selected by comparing Mean Absolute Percentage Errors (MAPE) where:

$$MAPE = \frac{1}{n} \sum \left| \left(\frac{Y_t - F_t}{Y_t} \right) \right| \cdot 100 \quad |$$

(2)

Where; Y_t = Observed value of time t, F_t = Forecasted value of time t

RESULTS AND DISCUSSION

Data analysis was done by the software MINITAB, and the data analysis consisted of three parts:

- i. ARIMA model testing on returns of Bogawantalawa Tea Estate Limited (BOGAW).
- ii. ARIMA model testing on returns of Agalawatte Plantation Limited (AGAL).
- iii. ARIMA model testing on returns of Watawala Plantations PLC (WATA).

TESTING ARIMA MODELS ON RETURNS OF BOGAW

The ACFs and the PACFs of the first difference series of BOGAW confirmed that the returns were stationary. Table 2 gives the summary statistics of the models tested:

Table 2: Summary of ARIMA outputs of BOGAW

Model	P value of the model	p value of Modified Box-Pierce (Ljung-Box) Chi-Square statistic At lag				MAPE in model fitting	MAPE in model verification
		12	24	36	48		
ARIMA (0,1,2)	0.000 ^a /0.054 ^b	0.008	0.028	0.014	0.017	122.375	107.298
ARIMA (0,1,1)	0.000	0.000	0.379	0.234	0.291	107.631	105.154
ARIMA (2,1,0)	0.000 ^c /0.000 ^d	0.138	0.102	0.155	0.217	142.75	137.880

a: P value of MA (1), b: p value of MA (2), c: P value of AR (1), d: p value of AR (2)

Based on summary statistics, it was concluded that the best model is ARIMA (0, 1, and 1):

$$Y_t = Y_{t-1} - 0.0001057 + 0.9965e_{t-1} + e_t$$

(3)

The Ljung-Box statistics give non significant p-values (>0.05), and indicated that the residuals were uncorrelated. The Anderson Darling test gave a significant p-value ($0.106 > 0.05$) for residuals, which indicated a normality of residuals. However, the MAPE was very high in both model fitting and verification. Therefore, the model was not recommended for forecasting.

TESTING ARIMA ON RETURNS OF AGAL AND WATA

Similar results were obtained when the same procedure was repeated for the returns of AGAL and the returns of WATA. The best fitting model for AGAL was:

$$Y_t = Y_{t-1} - 0.004 + 0.972e_{t-1} + e_t$$

(4)

And the best fitting model for WATA was:

$$Y_t = Y_{t-1} - 0.002 + 0.98e_{t-1} + e_t$$

(5)

As the MAPE of model (4) and (5) were also very high, they were not recommended for forecasting.

CONCLUSIONS AND RECOMENDATIONS

The predictability of per share returns in secondary markets is of immense importance to investors as well as the regulators of the market. This study was focused on testing ARIMA (p, d, q) models on the forecasting returns of individual companies on the CSE, sector-wise. A random sample of three companies in the Plantations sector (PLANT) was used in the study, and the required data was obtained from the CSE data library in 2011. The stationarity of the data was tested by auto correlation functions (ACF) and partial auto correlation functions (PACF). When the stationarity was confirmed, several ARIMA models were tested on a return series of individual companies. The best fitting model for each company was selected by comparing the Mean Absolute Percentage Errors (MAPE). The returns of all three companies were stationary type and the ARIMA (0, 1, 1) model was the best fitting model for all three companies. Ljung-Box statistics confirmed no correlation in residuals, while the Anderson Darling test confirmed the normality of residuals in all three models. It was concluded that a similar forecasting technique is suitable for forecasting returns of all the companies in the Plantations sector of the CSE. However, the MAPEs of the best fitting models were very high in both model fitting and verification. Therefore, ARIMA models were not recommended for forecasting.

The CSE has 20 business sectors, but this study was focused on only one of them. It is recommended to extend the study for more business sectors of the CSE.

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FORECASTING LONG-TERM INTERNATIONAL TOURIST FLOWS TO SRI LANKA

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INTRODUCTION

Sri Lanka is surrounded by scenic beaches and there are mountains, magnificent landscapes, exotic wild animals, natural ponds and water falls. The oldest tree in the world "Sri Maha Bo Tree" can be seen in Anuradhapura, Sri Lanka. World's leading and the most discerning and trusted monthly travel magazine in Britain "Condé Nast Traveler" has nominated Sri Lanka as one of the top five destinations to visit in year 2012 (MCNDSL, 2011). Over the past years international tourism in Sri Lanka has shown growth in two ways; growth of volume and value. There is an increasing trend in the volume of international tourist arrivals (Konarasinghe and Deheragoda 2013).

RESEARCH PROBLEM

With the increase in international tourist arrivals, the need for accurate forecasts of international tourist arrivals to Sri Lanka is essential. It provides direction for decision making and various planning at all levels, for long term and short term. But at strategic level long term forecasting is more appropriate than short term. It is a light house to make proactive, rather than reactive, decisions. Under these circumstances long term forecasting of international tourist arrivals to Sri Lanka is of immense importance and it is a timely requirement. In view of the above, the current study was conducted to identify a suitable mathematical model for forecasting long term international tourist flows to Sri Lanka.

METHODOLOGY

A mathematical model is an equation or set of equations which represents a behavior of a system. Mathematical models are categorized in several ways, namely; Static and Dynamic models, Deterministic and Stochastic models, Linear and Non linear models and Continuous and Discrete time models. A model is said to be deterministic if definite prediction of quantities is made without any associated probability distributions. To model reality, a deterministic model can be generalized by considering stochastic model. A linear model is one whose output is directly related to the input. In a linear model, all the model parameters appear linear. In a non linear model at least one parameter appears non linear. Linear models have straight line solution locus while non linear models have curved solution locus. Current study considers five types of stochastic models; two linear and three non linear models. They are;

$$\text{Linear trend model: } Y_t = \alpha + \beta_1 t + \varepsilon \quad (1)$$

$$\text{Quadratic trend model: } Y_t = \alpha + \beta_1 t + \beta_2 t^2 + \varepsilon \quad (2)$$

$$\text{Growth curve model: } Y_t = \alpha(\beta^t) + \varepsilon \quad (3)$$

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$$\text{Pearl – Reed Logistic model: } Y_t = \frac{A}{\alpha + \beta(\gamma^t)} + \varepsilon \tag{4}$$

$$\text{Univariate causal model; } Y_t = \alpha + \sum_{i=1}^n \beta_i Y_{t-i} + \varepsilon \tag{5}$$

Annual arrival data from 1968 to 2013 were obtained from statistical reports of 2012 and 2013 of Sri Lanka Tourism Development Authority (SLTDA). Model fitting was done by utilizing data from 1968 to 2001 and data from 2002 -2013 were utilized for model verification. Mean number of arrivals from year 1968 – 2013 were 351190. It was not close to zero. As such Mean Absolute Percentage Errors (MAPE) was used as model selection criteria;

$$MAPE = \frac{1}{n} \sum \left| \left(\frac{Y_t - F_t}{Y_t} \right) \right|. 100 \tag{6}$$

Where; Y_t = Observed value of time t, F_t = Forecasted value of time t

RESULTS AND DISCUSSIONS

Data analysis was done by software MINITAB. Figure 1 is the Liner trend model, Figure 2 is the Quadratic trend model, Figure 3 is the Growth curve model and Figure 4 is the Pearl – Reed Logistic model.

Figure 1: Liner Trend Model

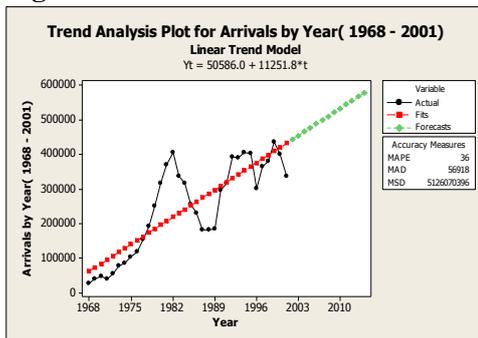


Figure 2: Quadratic Trend Model

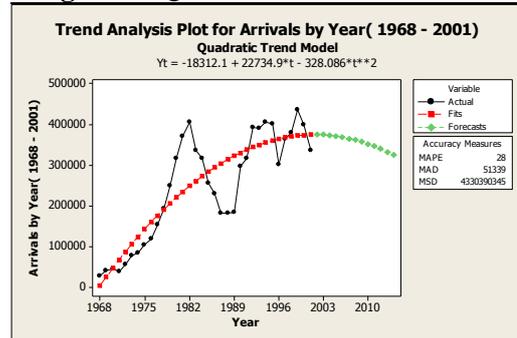


Figure 3: Growth Curve Model

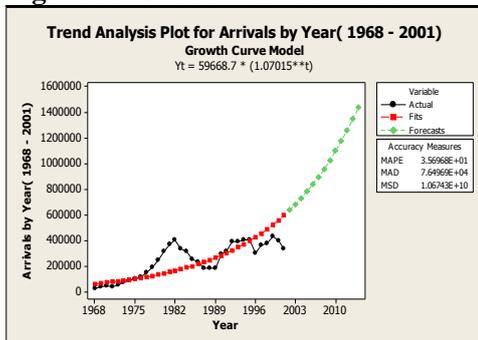
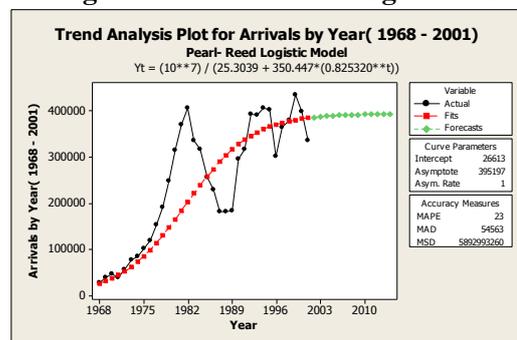


Figure 4: Pearl – Reed Logistic Model



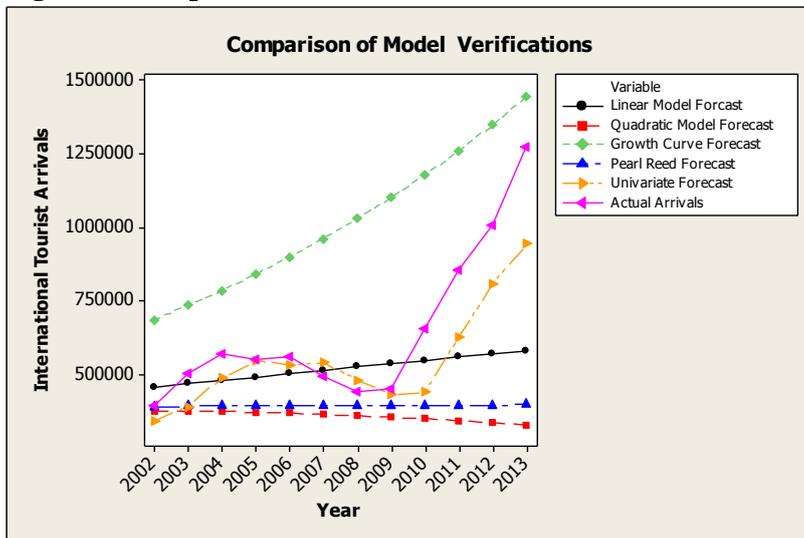
Univariate model was tested by regressing present arrivals on one lag behind arrivals. P value of the Univariate model is significant (p=0.000) and adjusted R² of the model is 88.1%. Table 1 gives the summary outputs of model fittings and model verifications;

Table1: Model Summary

Model	MAPE in Model fitting	MAPE in Model verification	Normality of residuals
$Y_t = 50586.0 + 11251.8t$	36	20.9	Normal
$Y_t = -18312.1 + 22734.9t - 328.086t^2$	28	37.2	Normal
$Y_t = 59668.7(1.07015^t)$	35	68.5	Normal
$Y_t = \frac{10^7}{25.3039 + 350.447(0.825320^t)}$	23	31.6	Normal
$Y_t = 32277 + 0.906Y_{t-1}$	17.7	15.4	Normal

Figure 5 is the comparison of model verifications. It clearly shows that Growth curve model over estimates the tourist arrivals. Quadratic trend model and Pearl- Reed logistic model underestimate the arrivals. Univariate model forecasts are very close to actual arrivals.

Figure 5: Comparison of Model Verifications



Based on model summary of Table 1, Univariate Causal model which has MAPE 17.7 for model fitting and 15.4 for model verification with normalized residuals is selected as the best fitting model.

CONCLUSIONS AND RECOMMENDATIONS

Forecasting international tourism flows to Sri Lanka was the objective of the study. Annual arrival data from 1968 to 2013 were obtained from SLTDA. Model fitting was done by utilizing data from 1968 to 2001 and data from 2002 -2013 were utilized for model verifications. Five types of stochastic, linear and non linear models were tested. Univariate causal model has the least MAPE in both model fitting and model verification. Adjusted R²

of the Univariate model is 88.1%. Residuals of all the models were normally distributed. Based on the above results it was concluded that Univariate Causal model is the best model for long term forecasting in international tourist arrivals to Sri Lanka.

This study was based on annual data. As such, models do not include seasonal variations. Therefore, it is recommended to extend the study by using monthly data.

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MARKETING ORIENTATION OF PHARMACEUTICAL SALES REPRESENTATIVES: A STUDY BASED ON KANDY DISTRICT IN SRI LANKA

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INTRODUCTION

The marketing concept was evolved in the mid 1950s as a customer centered approach which is targeted to satisfy customer needs. It has led several companies to gain superior advantage by adopting to the marketing concept. This marketing concept has become the basis to develop the concept of 'Marketing Orientation' (Kotler and Keller, 2012). Marketing orientation can be identified as a cultural scenario where all the employees of an organization are committed to create superior value to the customers (Narver and Slater, 1995). Marketing oriented firms can identify customer needs more easily and they can satisfy the customers more firmly. The adoption of marketing orientation leads to higher profitability, perceived value to the customer, customer satisfaction and customer loyalty. It can facilitate identifying and capturing new market segments while assisting decision making (Niculescu *et al.*, 2013).

The pharmaceutical market differs significantly from other consumer markets. The patient who consumes the product is not the decision maker and in most instances he / she is not the person who buys the medicine from a pharmacy. Also there is a distinct ethical, legal and regulatory control over the pharmaceutical market. The pharmaceutical market is less sensitive to price and it is an industry with complex, expensive research and development (R&D) practices. The main promotional tool in pharmaceutical marketing is personal selling using medical representatives. They promote branded products to doctors mostly through face to face interviews in order to increase the sales of the company. They have a considerable effect on doctors' prescribing behavior (Idris *et al.* 2011). Doctors who are exposed to medical representatives are willing to prescribe new drugs for their patients (Watkins *et al.* 2003). Studies on several countries have revealed that 80 – 95% of doctors regularly meet medical representatives in their practice. Therefore, the adoption of marketing orientation is an important approach for the betterment of the pharmaceutical companies and for patients. Therefore, the researchers have aimed to understand the marketing orientation practiced by pharmaceutical representatives. Particularly, there is a paucity of literature on the assessment of marketing orientation of pharmaceutical sales representatives.

METHODOLOGY

Based on the positivist paradigm, the researchers explored the marketing orientation of pharmaceutical representatives. Therefore, it is assumed that knowledge can be objectively acquired and measured using quantitative methods (Wyatt and Wyatt 2003). Thus, data collection was undertaken by conducting a survey through a structured questionnaire. The respondents were the sales representatives based in the Kandy district and they belong to three leading pharmaceutical companies. These companies were selected based on the researchers' understanding of the respective companies' marketing practices. The respondents were selected using simple random sampling technique in order to minimize the biasness of findings. The sample size of the study was 30 respondents which represents 10 respondents from each company. This study used descriptive statistics in analyzing the data. Several variables were used to identify the level of marketing of pharmaceutical sales representatives.

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These were product and market knowledge, desire to fulfill customer needs, types of career objective, attitude towards personal selling, degree of shift from transaction-based to relationship-based selling and the selling approach.

RESULTS AND DISCUSSION

Since there are not many studies about the marketing orientation of pharmaceutical representatives, variables were developed according to the basic marketing practices based on the marketing mix concept. According to the results some variables revealed positive signs towards the marketing orientation while some variables revealed negative signs towards the marketing orientation. There were 30 respondents to the questionnaire. Among them, 24 (80%) were designated as 'Medical Sales Representatives' while 6 (20%) of them were designated as Medical Promotion Delegates. Most of the respondents (29) were male while 1 respondent was female. Fifteen (50%) of the respondents were between 25 – 30 years of age while 6 (20%) were between 18 – 21 years, 5 (16.67%) were between 21 – 25 and 4 (13.33%) were more than 30 years of age. According to the findings, the majority of the respondents, 26 (86.66%) selected this career because of their interest in the pharmaceutical field.

Medicines were the main focused brand category for 28 (93.33%) of the respondents and two of the respondents were focused in nutraceuticals and diagnostic items. Most of the respondents, 16 (53.33%) believed that they do not have sufficient knowledge about the features of the product. Fifteen (50%) of the respondents think that they do not have enough time to update their knowledge whereas 5 (16.67%) thought that they have enough time. These results show some deviation from the marketing orientation concept because product knowledge is one of the most valuable aspects of marketing orientation.

From the medical representative's point of view, adding a margin for the cost of the drug is the most common method, (28 - 93.33%) of pricing medicine. Two respondents thought that pricing strategy is aimed at generating maximum profit whereas one each thought that it is for maximizing market share and surviving against competition, the majority (26[86.66%]) thought that the pricing strategy leads to increase awareness of brands. It shows some positive signs of the pharmaceutical field towards a marketing orientation.

Among the respondents 29 (96.67%) were creating a stimulus in the minds of doctors to prescribe their brand while only 1 (3.33%) was identifying and trying to fulfill the requirements of the doctors. These results show a lap in the marketing orientation as medical representatives are trying to persuade prescribers rather than trying to fulfill their requirements.

The ultimate career objective of 28 (86.66%) respondents was to fulfill their monthly target of sales and 2 (6.67%) respondents were trying to make their brand more popular. The career objective does not focus on their customers and it shows a deviation from the marketing orientation.

According to the respondent's view 11 (36.7%) identified personal selling as an important tool for promotion of medicine as it can convey the message with maximum information content. However 10 (33.4%) respondents do not agree with this. Personal selling is important for 8 (26.7%) respondents because it can reveal customer needs and wants with mutual flow of information. But 10 (33.4%) do not agree with this. These results show some positive features towards a marketing orientation.

Also 20 (66.67%) respondents think that personal selling can force the doctors to prescribe their brand. This percentage is very high and it is a deviation from a marketing orientation as it is about pushing the customer rather than satisfying. Among the respondents 12 (40%) think that the time available for interaction with doctors is insufficient whereas 13 (43.3%) think

that the time is sufficient and 11 (36.7%) respondents think that convincing doctors to prescribe the brand is easier than convincing others and 9 (30%) respondents don't agree with this. These two results also show lapses in the marketing orientation.

Also 18 (60%) respondents stated that their interaction is focused on building relationships while 5 (16.7%) opposed this idea. This is a very good point in accordance with marketing orientation as relationship marketing is an important point in marketing orientation.

According to the respondents, for 18 (60%) their primary purpose of interaction with doctors was to promote their brand. Yet, 11 (36.67%) stated that doctors should be pushed with incentives to prescribe their brand. These percentages show deviations from marketing orientation as it is about pushing the customer rather to purchase or prescribe what the medical representatives offer.

Awareness of the respondents of the market changes was considerably high 17 (56.67%). This result shows very important positive insights of the marketing orientation of medical representatives. The most important finding is that the pharmaceutical sales representatives, with an interest in the pharmaceutical field show a comparatively high marketing orientation. Therefore, it shows that when the sales representatives are much more interested in their job, they tend to practice marketing orientation properly.

CONCLUSIONS/RECOMMENDATIONS

The findings on the level of marketing orientation of pharmaceutical sales representatives show mixed results. Positive results towards the marketing orientation are demonstrated in the areas of building relationships with customers and higher knowledge about the markets. Moreover, they have a better view of identifying patient factors and patient needs in their marketing campaign. Also they have shown positive signs of marketing orientation by respecting the patient's right to decide the brand they purchase.

However there are some lapses in marketing orientation of pharmaceutical sales representatives revealed in this study. Less product knowledge and pushing the doctors to prescribe their brand can have a negative impact on the marketing orientation. Also the career objective of most pharmaceutical representatives shows deviation from the marketing orientation.

As recommendations, it is suggested to extend this study to the national level to get an idea about the marketing orientation of pharmaceutical sales representatives in the whole country. It will provide an idea about the marketing practice in the industry and it can show the way for companies to design their future marketing plan. Also it is suggested to perform more in-depth studies to reevaluate and find the reasons behind the lapses in marketing orientation. Such studies can facilitate to address the lapses in marketing orientation revealed by this study.

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MAKING “SIGNIFICANT OTHERS” PARTNERS IN MOTIVATING FRESHMEN OF THE B.Sc DEGREE PROGRAMME AT THE OPEN UNIVERSITY OF SRI LANKA: A PRELIMINARY STUDY

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INTRODUCTION

The term “Significant Other (SO)”^{1, 2, 3}, refers to someone that offers support and is interested in the well-being of a person irrespective of gender or the nature of relationship. SO may be a family member, employer, coworker, friend, lover or any other person in one’s life. Even though the term SO originated in the western world, the concept of SO has manifested in Sri Lankan culture in different forms for a long time.

The majority of the students entering the B.Sc. Degree Programme of the Open University of Sri Lanka (OUSL) are adolescents who have undergone formal education. Shifting to a Distance learning system where self-learning plays a prominent role may be a totally new experience for them.

In Open and Distance Learning (ODL) the interaction between the learner and the teacher is minimal. Hence, teachers have little opportunity of motivating the students. In that scenario, an SO may be considered as a valuable partner in motivating the student since he/she has much more interaction with the student on a day-to-day basis. Hence the concept of SO is highly relevant to the ODL educational environment that exists in the OUSL.

A study carried out at the University of Wisconsin¹ has illustrated the important role played by SOs in influencing the aspirations of the students in relation to their educational and occupational attainments. It revealed that the correlation between students’ aspirations and the SOs expectations is high and positive. A survey of study habits of some OUSL B.Sc. students of high academic achievement has revealed that a majority had a person significant to them taking a keen interest in their progress⁴. Survey data collected from a sample of students of the B.Sc. Degree Programme in 2010/11 also indicated that most of them have either a close family member or a friend as a SO.

Many higher educational institutions throughout the world have developed induction/familiarization programmes² for freshmen for the purpose of getting their parents involved in dealing with specific problems such as alcoholism, dating etc. However, programmes on the involvement of SOs in motivating freshmen for their educational progress are rarely reported.

To harness the best advantages of this novel concept, a Programme to introduce SOs to the OUSL system was included as a sub activity in the Higher Education for the Twenty First Century (HETC) grant proposal which was submitted to the World Bank and subsequently the grant was awarded to the Faculty of Natural Sciences in December 2013. This activity was focused on finding out the possibility of using SOs in motivating the freshmen for their studies and to seek the possibility of establishing a sustainable partnership between SOs and OUSL.

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This preliminary paper investigates and presents the progress made by the Faculty of Natural Sciences in introducing the SO Programme, especially in relation to creating a positive attitude to the concept among both students and the SOs. It is expected that this information will be of vital importance in further developing this programme and also for the other faculties which may venture into such programmes in the future.

METHODOLOGY

At the 3-day Induction Programme conducted for the freshmen of the BSc Degree Programme in the academic year 2013/2014, half an hour of the 2nd day was devoted to explaining the SO concept and its benefits to the students. After giving the students sufficient time for digesting the concept of SO, at the end of the 3rd day the students were requested to identify a SO if they had one.

Identified SOs of the students registered at the Colombo Regional Centre were invited (through letters and a reminders through SMS) to a seminar to give them a better understanding of the OUSL study system and to discuss how they could help their “loved ones” in achieving his/her educational goals. Spending an adequate amount of time for study, spreading out studies throughout a semester and developing sound study habits by a student were explained as major determinants of success at OUSL, in a half hour presentation. SOs was requested to help their loved ones in achieving these goals.

Following the initial presentation an expert in educational psychology addressed the SOs on how to render psychological support to students and how to understand their loved ones better so that they could help the student in achieving the said goals. SOs were also made aware of some of the motivational techniques that could be applied. Unstructured interviews with the SOs followed with the collection of further information through a post session questionnaire.

RESULTS AND DISCUSSION

Figure 1 below summarises the different categories of SOs Identified by the students (562 Nos) who attended the induction programme at the Colombo Regional Centre (CRC).

Figure 2 below summarises different categories of SOs (46 Nos) who attended the CRC seminar.

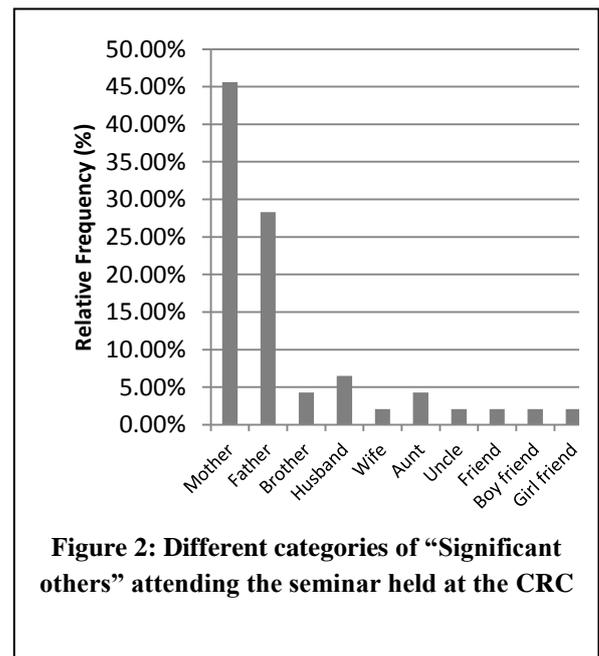
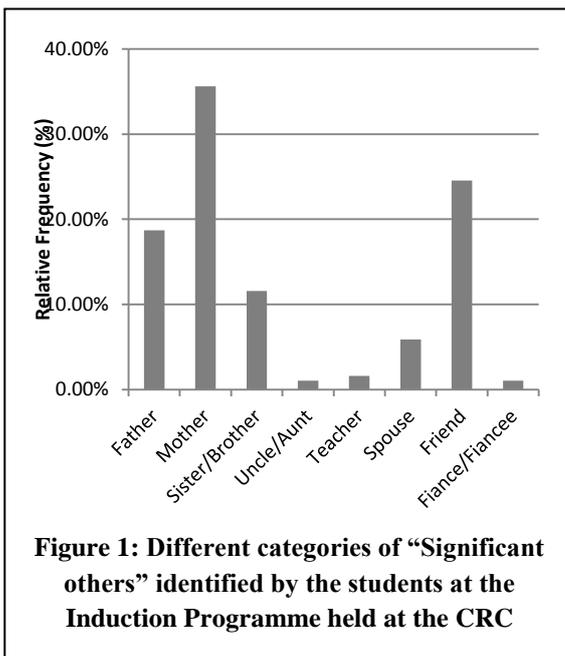
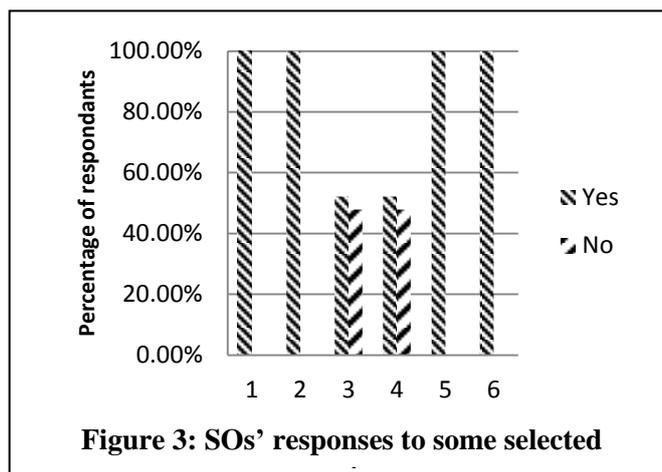


Figure 1 shows that in agreement with previous studies, the majority of students had identified their close family members as persons who could be trusted to play the role of SO. A reasonable percentage of freshmen had also trusted their friends as persons who could have an influence in their lives. As expected the attendance at the SO seminar was also dominated by mothers and fathers (Figure 2). However, it is interesting to note that individuals with other relationships had also attended the SO seminar. Although the number who attended in such categories is small, continued effort has to be made by the OUSL to encourage them to attend such seminars and develop this new partnership which would benefit their loved ones.

During the question/discussion time many expressed their views on the new idea of getting help from SOs. They valued very much the talk by the expert who enabled the SOs to think about the psychological aspects of an adult student’s life and how to deal with instances where they needed support. In fact they wanted their loved ones too to listen to the talk. It was a clear indication of the willingness of the attendees to engage in the activities of the new programme and the success of the seminar.

Table 1: below illustrates some questions included in the questionnaire for the SOs

Question no	Question
1	Did you <u>enhance</u> your understanding of the commitment expected of a student in the Open University during this seminar?
2	Do you believe that a person close to the student may be able to help him/her in difficult situations and this is similar to the role described as “SO” in the seminar?
3	Were you aware of the term “SO” before attending this seminar?
4	Were you aware of how a SO could help a loved one in securing a Degree before attending this seminar?
5	After listening to the seminar did you get a good understanding of how a “SO” can help your loved one in securing a B.Sc Degree?
6	Do you think this newly introduced programme will be helpful in motivating your loved one (following the B.Sc Degree)?



It is encouraging to note that all 46 potential SOs had responded positively to questions related to the role of a SO which indicates that they had developed confidence in the new programme. The response to question no.6 on whether they received a better understanding of the commitment expected of an OUSL student by attending the seminar was very satisfactory. Again this is a clear indication of the success of the workshop through which a new set of partners are encouraged to participate in motivating the students.

SOs made several useful suggestions in responding to the open ended question on how the OUSL can help them in performing their expected role. Their suggestions including the necessity of holding frequent seminars and discussions in the future is a clear indication of how well they were convinced about the usefulness of the programme and their commitment and eagerness to play an active role ensuring the wellbeing of their loved ones.

One other suggestion expressed by all of them was the request to provide the opportunity to make the students too, active partners of the programme by inviting them to at least some of the selected activities.

Although it is clear that the SOs who attended the event benefited, the number of SOs who attended the seminar was not satisfactory. However, it has to be stated that building up a partnership between a higher educational institution and a set of SOs, (identified by students) in developing a programme for motivating learners to study is novel and may take some time to be established.

CONCLUSIONS/RECOMMENDATIONS

In general, the initial phase of this new programme that made an attempt to incorporate SOs into the educational environment of the OUSL has been successful. It created a positive attitude and confidence regarding the SO programme in the minds of potential SOs. It also provided them an opportunity to translate their feelings and expectations in relation to the wellbeing of their loved ones into a more practical and meaningful one. While being satisfied with the initial success of the programme, it is of paramount importance to have a well formulated mechanism to monitor its success so that continuous improvement can be achieved.

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**STUDENT PERCEPTIONS ON THE NEWLY INTRODUCED CONTINUOUS
ASSESSMENT TEST(CAT) SYSTEM IN THE FACULTY OF NATURAL SCIENCES
AT OUSL:A SURVEY**

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INTRODUCTION:

The Continuous Assessment Test (CAT) is defined as an assessment of a pupil's progress throughout a course of study, rather than exclusively by an examination at the end of it (Collins English Dictionary, 2003). The Open University of Sri Lanka (OUSL) practices the CAT system as a prerequisite for the final examination of the Bachelor of Science programme through No Book Tests (NBT), Open Book Tests (OBT) or Practical evaluations. A minimum CAT mark is required to be "Eligible" to sit for the final examination of a particular program (Undergraduate Hand Book, 2014). From its beginning, the Faculty of Natural Sciences has conducted the CAT system throughout a semester in parallel with limited contact sessions ("day schools"). The faculty, after recognizing some of the drawbacks in the past CAT system such as inappropriate time management, no extra focus on exams and inadequate planning leading to poor academic performances, made plans to introduce a new CAT system in 2012. This new system consists of a single CAT period of seven consecutive days throughout the week of a semester. The new CAT system was approved by the Faculty Board of Natural Sciences, OUSL, and was implemented from the first semester of the 2013/2014 academic year. The present action research was intended to evaluate the ongoing processes of this newly implemented CAT system and to help to identify any immediate problems, thereby providing the opportunity for a reflective process on the progress of the system.

Objectives of the survey:

- Quantify the students who agree/disagree with the newly introduced CAT system
- Trace the reasons for their opinions
- Examine the suggestions made by students to improve the new CAT system

Methodology:

This study, to evaluate the newly introduced CAT system, consisted of a preliminary screening survey, conducted with a prepared questionnaire at three OUSL Regional Centres viz., Colombo (CRC), Matara (MRC) and Kandy (KRC). Prior to making the study tool, 137 students were interviewed to get their suggestions and the questionnaire was piloted according to Lizzio *et al.* (2002) and Kuruppearachchi *et al.* (2012a and 2012b). The section of the screening survey, which provided direct "Yes/No" answers, was categorized as section I. The questions asked in sections 2 and 3 were open-ended and facilitated the recognition of the main reasons for rejecting or accepting the CAT system, as well as to perceive the suggestions made to improve the system. Additionally, the questionnaire facilitated the gathering of information on the enrolment year, the distance from a student's permanent residence and the employment status of the student.

The piloted questionnaire was administered during academic sessions after the students' first CAT, using a total of 587 students from the CRC (452), MRC (98) and KRC (37), which represented about 15% of the total number of students registered in the faculty for the

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2013/2014 academic year (ca. 3800). Open-ended questions had a great diversity, as well as similarities, in responses. Some different responses tended to have similar meanings. All responses were examined and then main categories were chosen. Each individual response was analyzed and placed in the relevant category.

The responses to the open-ended part of the questionnaire (section 2 and 3) were used for descriptive purposes with their calculated response frequency percentages (American Association for Public Opinion Research, 2000).

RESULTS AND DISCUSSION

The number of students who agree/disagree with the CAT system

The preliminary interviews showed that 93% (127 out of 137 students) of students disagreed with the newly introduced CAT system. Results of the piloted questionnaire showed that from a total of 587 students, 89.6% (526) disagreed with the newly introduced CAT system. This included 87.6% (396) of students from the CRC, 95.9% (94) and the MRC and 97.3% (36) from the KRC.

The perceived reasons for agreeing or disagreeing and the perceived solutions to improve the new CAT system, obtained from sections 2 and 3 of the open-ended part of the questionnaire, are summarized in Tables 1 and 2:

Table 1: Students Perceptions: Reasons and solutions given by students (total 526) who disagreed with the new CAT system

Reasons for the selection of the option	Response Frequency %	Suggestions	Response Frequency %
Insufficient gaps, overlapping, clashes, congested, more exams within a short period	40% (210)	Spread CAT throughout the semester as in the earlier system	25% (135)
Conflicts with employment (leave and administrative problems)	15% (79)	If not, need more time gaps; increase the CAT period, and not continuously for 5 days	23% (120)
Time management problems (no time to prepare for exams)	6% (31)	Conduct on weekends, holidays or school vacation time	16% (88)
High exam stress/ tired/ mental distress	8% (42)	Avoid more than 1 or 2 subjects per day (one NBT and 1 OBT per day preferred)	11% (60)
Poor performance (number of subjects, short duration, lack of time for Refreshing knowledge, overall grade (GP) will decrease)	8.4% (44)	Needs a day school before or on the same day as the CAT	9% (48)
If illness or other problems during the CAT period, whole exam may be affected	2.8% (15)	Do not arrange day school with CATs on the same day	2% (14)
Intolerable/ unmanageable work load within 5 days	4.6% (24)	Duration – afternoon (1-3pm). Do not arrange CATs too early or until 5.30pm	7% (41)
Due to CAT, other academic work become congested and is affected	4% (21)	The arranged timetables to be sent properly and in advance, with sufficient instructions	2.1% (11)
Physical space (exam hall, hostel, library, etc.) problems	2.68% (14)	Improve library, hostel, and hall facilities	2% (10)

Transport difficulties due to change of starting and ending time of CAT (8.45am -5.30pm)	2% (10)	Increase study leave (to more Than 30 days)	1% (6)
Students with 36 credits suffer more compared to less the students registered for less credits.	1.4% (7)	Increase paper duration as the earlier system (1-1½ hours).	1 % (6)
CAT duration has been reduced to one 1 hour from 1½ hours	1.3% (7)	Give sufficient days for practical sessions after the CATs	0.84% (4)
Difficulty reading 20 or more books within 5 days	0.92% (5)		
Other reasons not mentioned above	2.9% (15)		

Table 2: Students Perceptions: Reasons and solutions given by students who agreed (total 61) with the new CAT system

Reasons for the selection of the option	Response Frequency%	Suggestions	Response Frequency%
Managing time, planning for studies and focusing on studies was very easy due to the new CAT system	39.62% (24)	Have time gaps between CATs	34% (20)
Sufficient time to prepare for studies	11.32% (07)	Restrict CATs to a maximum of 01 or 02 CATs per day	22% (13)
Better system for employed students	15.09% (09)	Extend the CATs period to two weeks (holidays/weekends)	16% (10)
Once completed, no need to focus on studies (like other conventional universities)	9.4% (06)	Issue a well-prepared timetable in advance	12% (07)
If students registered for a few subjects, it was more convenient	7.5% (05)	Arrange CATs during the afternoon or normal working hours	8% (05)
It has separated days schools and CATs, and is better for self-learning	7.5% (05)	Give online exams, MCQs or easy papers	4% (02)
Study time will increase due to The new CAT system	5.6% (03)	Don't reduce CAT paper duration to 1 hour from 1½ hours	2% (01)
Easy to coordinate other work (no exam every time)	3.7% (02)	Provide sufficient time between Practical sessions and CATs	2% (01)

The survey results indicated that a majority of students (*ca.* 88% CRC, 96% MRC and 97% KRC) disagreed with the new CAT system. Conducting exams from 8.45am to 5.30pm for seven consecutive working days created unhappiness, distress and uncertainty among students. The responses indicated that students believe that the “intolerably heavy work load during a short time period will lead to poor academic performance in the future” and would turn out students who are “tired and stressed, with no confidence in exams”. The responses also suggested that administrative problems and a lack of planning and communication had worsened the situation. All parties (both opposing and supporting) requested for a properly scheduled timetable. Improper hall allocations and a lack of hostel and library facilities had also created a negative perception. However, with proper planning, it would be possible to overcome such administrative drawbacks.

A majority of the undergraduates who took part in the survey were employed (60% in CRC and 87% in MRC) and the structure of the new CAT created a conflict between the employment place and studies. This may be a reason why a vast majority of students rejected

the CAT system. A considerable number of students (33% for CRC and 37% for MRC) travel to the relevant regional center from their permanent residence or place of employment, which is situated more than 91km away. The CAT starting early and ending at 5.30pm make transportation difficulties for the above category. Additionally, the new CAT had created problems, such as overcrowding in hostels and libraries and causing students to travel daily from their residences (Table 1). Students perceived that the structure of the new CAT system itself violated Open Distance Learning (ODL) concepts (*i.e.* flexibility and the facilitation of adult learners to study in their own place).

Previous studies on the psychological distress of undergraduates of Sri Lanka (Kurupparachchi *et al* 2002; 2012a) found that Bachelor of Science undergraduates of OUSL are comparatively more distressed (64%) than others. These studies revealed that a majority of students were under stress due to the CAT system. Hence, more attention should be paid when dealing with such vulnerable groups of students. The lesser number of students in the present study who agreed on the new CAT system stated that the “*Academic and administrative work is very easy and convenient*” due to the new CAT system and it “*saves the time of staff and students*”, makes it “*convenient for students to focus on and manage exams and hence increase academic performance*” and makes it “*easy to plan or schedule their academic work easily.*” However, the suggestions made by them were almost similar to those who disagreed with the new CAT system (Table 2), implying that they face similar difficulties due to the new CAT system.

CONCLUSIONS/RECOMMENDATIONS:

The present study indicated that a majority of students have a negative attitude to the newly introduced CAT system. A majority of employed students do not like the new CAT system, which is held consecutively on seven days, due to problems such as the taking of leave from employers and other commitments, while full time students who are registered in more course units also felt intolerable exam pressure due to the new system.

It can be concluded that a large number of students agreed on the need to expand the CAT period throughout the semester, conduct of CAT during weekends and reduce the number of CATs per day (Tables 1 and 2). Students should be provided with sufficient gaps between CAT exams. If the authorities educate the students prior to implementing the new system, many disagreements/disappointments could be avoided. However, as students could get used to the new system with time, the disagreement percentage may be reduced in the future. To evaluate the attitudinal changes that take place with time, similar surveys can be recommended for the same student group after the second and third CAT exams. This would help to provide a clearer picture on the use of the new CAT system. It is also recommended to arrange CAT exams during weekends and that they should not be confined to week days. The duration of the CAT period should be increased to 3 or 4 weekends, and conducted between 9.30am and 4.30pm.

It is important to mention that if the education system creates unfavorable situations or damages the self-esteem of adult learners, they will easily make a decision to give up their education program, and thereby increase the trend of dropping out from the Bachelor of Science degree program at OUSL in the future.

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ADULT LEARNERS' REFLECTIONS ON OBSTACLES AND CHALLENGES IN DISTANCE EDUCATION: A CASE STUDY OF LEARNERS IN THE DIPLOMA IN ENGLISH AND ELT.

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INTRODUCTION

While much research has been carried out in relation to pedagogy in Distance Education (DE) there has also been growing interest in understanding the conditions under which adult learners study and the obstacles and challenges they face in learning in DE programmes. Exploring the obstacles that face adult learners has become increasingly important because obstacles often lead to non-completion of programmes offered in the DE mode. The issue of variable completion rates requires immediate attention as it undermines the cost efficiency argument for ODL (Raza, 2008). Raza (2008) explored the issue of non-completion of Open and Distance Learning (ODL) students and noted that it is a feature that is found in a large number of ODL institutions in South Asia, of which OUSL was one of the institutions investigated. Raza(2008) notes that non completion rates are highest in undergraduate programme whereas completion is highest in postgraduate programmes.

Many studies which focus on the obstacles and challenges faced by adult learners in DE environments have been carried out. Ostlund's (2005) study indicates that learners identified three main areas which they felt affected their studies in a negative way: circumstances in their domestic lives, circumstances in their work lives and lack of experience with studying. Similar concerns are noted by McGivney(2004) whose study showed that adults who embark on longer qualification programmes (in both conventional and DE settings) can be affected by factors not shared by younger students who have stayed on in full time education. They are more likely to have a range of external constraints arising from their work, domestic and financial commitments. McGivney's research highlights the fact that the non-completion is a complex issue and that it is affected by personal factors (such as gender differences, lack of family or partner support, financial constraints) as well as institutional factors. She notes that inadequate pre- course information and guidance, less guidance on how to manage study time in DE institutions and a lack of support from institutions can pose barriers to successful engagement of adult learners in study programmes. Morgan and Tam's (2006) study which adopted a case study approach, and in which students of a single study programme were studied, also indicated that no single factor could be linked to students' persistence or withdrawal from a programme. These factors could be situational (relating to student's life circumstances), institutional (difficulties that students experience with institutions), dispositional (issues such as learning styles) and epistemological (impediments caused by the subject matter itself). All these studies point to the complex nature of the multiplicity of factors that can affect success in ODL organizations. This study therefore situates itself in the wider body of research that looks at the factors that affect the success of adult learners in ODL intuitions.

The study focuses on the students on the Diploma in English and ELT offered by the Department of Language studies and looks specifically at the factors that affected learners in completing the programme in the stipulated time period. The objectives of the study were

- to identify the factors/ issues that students perceived as having impinged on the success of their studies

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- to suggest possible areas of improvement to help students complete their study programme

It was hoped that the findings of this study could highlight areas of learner support that could be addressed to improve learners' ability to complete study programmes within the stipulated time period.

METHODOLOGY

The current study adopted a case study approach which as Stake (1995) notes is a study methodology which gives prominence to the "particularity" and the "complexity" of a single case which enables a deeper understanding of the phenomena. The sample in this research consisted of 42 students who had completed the Diploma in English and ELT. These students were asked to reflect back on their experiences and identify issues/ problems that impinged on their performance in the Diploma in English and ELT. This study utilized a mixed method approach which involves the collection and analyzing of both quantitative and qualitative data. The primary method of data collection was a questionnaire which used both closed ended questions as well as open ended questions which allowed the participants to reflect on their experiences in this particular study programme. All data were gathered anonymously and participants were informed that confidentiality would be maintained in the process of data collection. The data thus gathered was analyzed quantitatively as well as for overall themes that captured the participants' experiences

RESULTS AND DISCUSSION

A total of 42 students who had completed the Diploma in English and ELT which in effect comprises the first two years of the BA degree programme offered by the Department of Language Studies formed the sample of this study. 39 students in the sample were female while three students were male. This predominantly female sample reflects the gender composition of the student population of this programme. Of the 42 students who participated in the study 60% reported that they had not faced any specific obstacles in completing the programme in the stipulated time period. 40% stated that they had faced obstacles in engaging with their studies which impinged on their success. Of these, 14% of the sample population needed to re-sit exams, 11% of the students had to repeat the course and a further 11% had to postpone their examinations. Thus 40% of the sample population faced obstacles which meant that they took longer than the minimum stipulated time period of two years. It is also important to note that many of these learners had previous experience in studying in higher education as well as in other DE programmes.

The quantitative data also indicated key areas which all learners cited as obstacles in studying as adult learners who had to balance a multiplicity of roles.

Table1: Factors that impinged on successful study

Type of Problem	% of students
Family	23%
Career	33%
Time management	40%
Subject matter	19%
Other	11%

The quantitative data were therefore able to indicate broad areas which adult learners perceived as challenges in relation to success in their studies. These areas broadly coincide with findings of similar studies carried out with adult student populations.

The qualitative data component of the questionnaire asked students to reflect on their experience of study in the Diploma in English and ELT and to cite possible actions/methods that they and the institution could have performed differently to make their learning experiences more positive and successful. It was significant that much of the qualitative data in relation to these questions when analyzed highlighted areas that were broadly congruent with the obstacles identified above.

In relation to studying in the DE mode and time management these learners cited making time for independent study and research, attending day schools and spending adequate time for assignments as priorities in their study programme. Not postponing exams and taking a fewer number of courses was also considered important. Learners also noted the importance of managing family obligations and responsibilities as key factors. This could be due to the fact that a majority of participants were female. However many learners also noted the support of their family as a positive factor that motivated them to continue with their studies.

In relation to institutional factors that impinged on their success, learners noted the importance of being given proper understanding of institutional norms such as exam procedures (rules regarding re-sitting for exams) and registration procedures. In relation to the delivery of content they noted the need for more face to face contact hours as well as issues such as scheduling of academic activities and time allocated for completion of assignments as well as improved coordination between the various departments and divisions of the OUSL.

CONCLUSIONS/RECOMMENDATIONS

While it may not be possible for the institution to address all personal issues faced by students, there are some areas which pose challenges to students which can be addressed by the institution in an attempt to facilitate completion of courses among adult students. Since the quantitative data indicates that 40% of the students in the sample cited time management issues as an obstacle, it may be possible to incorporate a component dedicated to teaching students time management in either the orientation sessions or later on after the study programme commences. Further, a more detailed work plan which indicates time to be spent, on assignments, lesson material, and extra reading would aid students in planning their academic activities and help them to deal with the demands of this academic programme.

In relation to students' perceptions that their lack of awareness of norms related to exam procedures and other institutional norms such as re-sit and registration rules, it is noteworthy that currently all students are given a student handbook which contains all the relevant information. It can therefore be concluded that students need more contact with the institution and a flexible system of feedback related to assignment scheduling and clarification needs to be developed, with students being made to feel free to clarify any points related to academic and administrative procedures. Overall more opportunities for communication between students and staff may help create an environment in which students feel less isolated and intimidated by institutional rules and regulations. Mid programme counseling may also assist in increasing student support from the institution to facilitate higher completion rates. Since a majority of staff members have a background of studying in conventional learning systems, it is recommended that more training be given in specialized student support procedures, (in addition to the currently provided course material development training) relevant to ODL contexts.

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USAGE OF INTERNET AND COMPUTER AMONG SRI LANKAN UNIVERSITY STUDENTS

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INTRODUCTION

The world has become a global village with the development of Information and Communication Technology (ICT). New knowledge can be retrieved by anyone from anywhere in the world with the use of ICT. ICT has also made it possible to disseminate new knowledge all over the world within a short period of time. . Education is moving forward with the use of ICT and especially in higher education, ICT has become an essential instrument in expanding borderless education in the modern world through open and distance education, online education, and open educational resources. Therefore, the use of computer and internet is essential for university students for successful completion of their studies. According to the Household Computer Literacy Survey (2006/2007), computer literacy of the general Sri Lankan population has increased to the value of 11.4 % (Department of Census and Statistics Sri Lanka, 2009).

Limited access to the printed books and journals and difficulty in obtaining up to date information from the printed materials badly affect the performance of students at examinations and these students find it difficult to get a job after graduation. Furthermore, poor computer knowledge can adversely affect the collation and analysis of data as well as the final quality of the research work and after graduation it may have an adverse impact on postgraduate education (Ranasinghe et al., 2012).

Although the majority of Sri Lankan medical undergraduates (80%) had their own computers (Ranasinghe et al., 2012), these undergraduates had a low-intermediate level of computer literacy. There is a need to improve their computer literacy as they have to use computers for word processing, web browsing and making presentations. It was found that the majority of students had used a computer (93%) or Internet (60%) at the point of entry to the University of Colombo. There is a need to study the patterns of undergraduates of Engineering, Commerce and Arts faculties as they have not been investigated sufficiently. Hence, the purpose of the present study was to find out the patterns of usage of internet and computers by the university students for study purposes. The objectives are to find out the ways in which computer facilities are obtained by university students for their studies; to identify the ways of obtaining the internet facilities; to identify the reasons if computer/internet is not used and to identify the purposes for which internet is used by university students.

METHODOLOGY

The study used the Survey research method.. The population was the undergraduates of Sri Lankan state conventional universities. The sample consisted of students from three faculties of three universities (University of Colombo: Faculty of Arts, University of Sri Jayewardhanapura: Faculty of Management, University of Moratuwa: Faculty of Engineering) . Using the stratified random sampling method, 50 students were selected from each Faculty (n=150) and data from them were collected using a questionnaire. 5 students from each Faculty (n=15) were interviewed. Quantitative data were tabulated and percentages were calculated. Qualitative interview data were coded to identify patterns and these patterns were quantified and converted into percentages.

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RESULTS AND DISCUSSION

Majority of students of the Engineering Faculty (72%) and the Management Faculty (64%) used their own computers (Table 1). Students responses for 'not using of computers' were very low (less than 30%) from both Faculties of Engineering and management which means that many of them use internet and computer facilities for their studies. However, 30% of students in the Faculty of Arts have their own computers. Few students from the Management (10%) and the Engineering (12%) Faculties used university library computers. Majority of students from Engineering (64%) and Management (48%) Faculties used internet facilities at home while only a few students (6%) from Arts Faculty used internet facilities from their homes. Majority of Arts Faculty students (66%) used internet facility at the university library as many of them did not have personal computers and internet facilities at their homes.

Table 1: Usage of the Internet facilities and the computers by the University students

Faculty		The Computer you used belongs to				Internet facilities received from				If computer/internet do not use			
		You	Relation or Friend	Library	Other	Home	Library	Internet cafe	Other	No skills	Not necessary	No opportunity	Other
Engineering	Sub total	36	5	6	3	32	14	2	2	4	3	2	2
	Percentage	72%	10%	12%	6%	64%	28%	4%	4%	8%	6%	4%	4%
Management	Sub total	32	9	5	4	24	9	8	9	3	2	10	0
	Percentage	64%	18%	10%	8%	48%	18%	16%	18%	6%	4%	20%	0%
Arts	Sub total	15	5	25	5	3	33	6	8	10	4	30	2
	Percentage	30%	10%	50%	10%	6%	66%	12%	16%	20%	8%	60%	4%
All three Faculties	Grand total	83	19	36	12	59	56	16	19	17	9	42	4
	Percentage	55%	13%	24%	8%	39%	37%	11%	13%	11%	6%	28%	3%

8% of the Engineering Faculty students, 6% of Management Faculty students and 20% of Arts Faculty students said that they did not have sufficient skills to use a computer or internet. Majority of Arts Faculty students (60%) and 20% from Management Faculty and few students (4%) from Engineering Faculty said that they did not have opportunity to use a computer/internet.

When the data from all three Faculties were analysed as a whole, the results showed that 55% of students used their own computers and 24% of them used library computers. Majority of the university students had their own computers. Majority of university students received internet facilities from home (39%) and 37% of them received internet facilities from the library. 28% of students had mentioned that they have the opportunity to use computer and internet for their educational activities .

According to the interview data (Table 2), most of the students from Management and Arts Faculties used internet facilities for educational purposes. Majority of the students of the Faculty of engineering used internet for other activities such as listening to songs, films and social networks like face book. Considerable number of students in the management and the engineering Faculties used internet facilities for other purposes. Playing of online or offline computer games were comparatively low among the university students. As a whole, majority of university students browsed the internet mainly for educational purposes, secondly for other purposes, least for playing games. The areas of Internet browsing changed from time to time. The study showed that browsing the internet in the educational areas was done during

the examination period.

Table 2: Browsing of the internet in three areas (Annual average of using of internet)

Student	Education			Games			Other		
	Engi.	Man.	Arts	Engi.	Man.	Arts	Engi.	Man.	Arts
1	80%	50%	80%	5%	10%	0%	15%	40%	20%
2	30%	69%	70%	25%	0%	0%	45%	31%	30%
3	34%	80%	40%	1%	0%	30%	65%	20%	30%
4	70%	60%	50%	0%	15%	40%	30%	25%	10%
5	40%	75%	60%	0%	5%	10%	60%	20%	30%

CONCLUSIONS/RECOMMENDATIONS

CONCLUSIONS

- Majority of Management and Engineering Faculty students have their own computers/ internet facilities and use their own internet facility.
- Majority of Arts Faculty students do not have their own computers and internet facilities. They use internet facility from the university library.
- 20% of Arts Faculty, 8% from Engineering and 6% from Management Faculties students do not have sufficient skills to use computer/internet
- Majority of Arts Faculty students do not have an opportunity to use computer/internet facility for their studies.
- Majority of university students browse internet for educational purposes
- Playing computer games are comparatively low among the university students.
- Browsing internet: for social networking and for the other entertainment (Films, songs etc.) was average among the university students. Engineering Faculty students were more interested in browsing the internet for entertainment than the students of other two Faculties.

RECOMMENDATIONS

- University students those who have no money to buy a computer should be given financial aid in the form of low interest loans to buy computers.
- University students should be provided with Wi-Fi internet facilities for low cost or free of charge within the university premises..
- Universities should improve and develop the capacity of computer labs with internet facilities.
- Students should be given an opportunity to develop their skills to work with computers and internet when doing their academic activities.
- Students should be directed to use the internet for educational purposes.
- Students should be encouraged to use social networks for their educational activities.

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PHENOTYPIC VARIATION IN *Mycalesis perseus* BUTTERFLY POPULATIONS IN DIFFERENT CLIMATIC ZONES OF SRI LANKA

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INTRODUCTION

Certain species of butterflies, including *Mycalesis*, has been shown to exhibit polyphenism in wing pattern and body size influenced by environmental cues (Braby 1995). These investigations report such phenotypic variations are most likely to represent responses to external signals such as differences in environmental, behavioural and nature of predation and propose polyphenism to be a survival strategy to face the local environmental conditions.

Mycalesis perseus is the commonest of the genus found in Sri Lanka with an island-wide distribution, frequenting open habitats as well as forest habitats (Ormiston, 1924). These butterflies avoid low humidity high temperature areas preferring the early morning or late evening to be active. *M. perseus* butterflies are brown in colour adorned with ocelli on both the dorsal and ventral surfaces. The presence of polyphenic wet and dry season forms with variation in morphological characters has been described in past literature for adult *M. perseus* in Sri Lanka (Ormiston, 1924; Goonesekera, *et. al.*, 2013).

Although the phenomenon of ecological adaptation has been reported in several butterflies in other parts of the world (Kingsolver & Wiernasz, 1991), such studies on local adaptation or those that investigate distributions of butterfly phenotypic characters between populations in the different climatic regions across Sri Lanka are almost non-existent. The aim of this study therefore was to investigate how the morphometric parameters of wing, genital and foreleg characters in *M. perseus* vary between populations in the Wet, Dry and Intermediate climatic zones across Sri Lanka and whether these phenotypic differences reveal any preliminary evidence for local adaptation of populations to the regional climate.

METHODOLOGY

Sampling: Sixty six adult specimens were collected from 2012 to 2014 from 13 districts representing the Wet (39), Intermediate (17) and Dry (10) Zones of Sri Lanka. Adult butterfly specimens were captured using nets and baited traps. Specimens were identified with standard taxonomic keys prior to preserving as voucher specimens. Genitalia were dissected and forelegs cleaned of hair and scales before observation under a stereo microscope.

Morphometric measurements: A morphomatrix of 17 wing, 5 foreleg and 6 genital character elements (Fig. 1) was established. Measured wing characters were represented as a relative size of forewing length from Base to Apex (BA). Similarly, Total Clasper Length (Tcl) for genital characters and Total Length of foreleg (TL) for foreleg characters were used. Colour of both dorsal and ventral surfaces of the forewing was measured in the proximal half of the discal cell from a 5x5 pixel area using ColorPic software (ICONICO) and the results were converted to an ordinal scale.

Statistical analysis: Principal Component Analysis (PCA) was performed for wing, genital and foreleg characters selecting components with Eigenvalues greater than one. Variables

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with >60% loading values were considered significant and selected for further analysis by One-Way Analysis of Variance (ANOVA) and by *post-hoc* test to determine the source of climatic zone differences for principal components (PC) and morphometric variables.

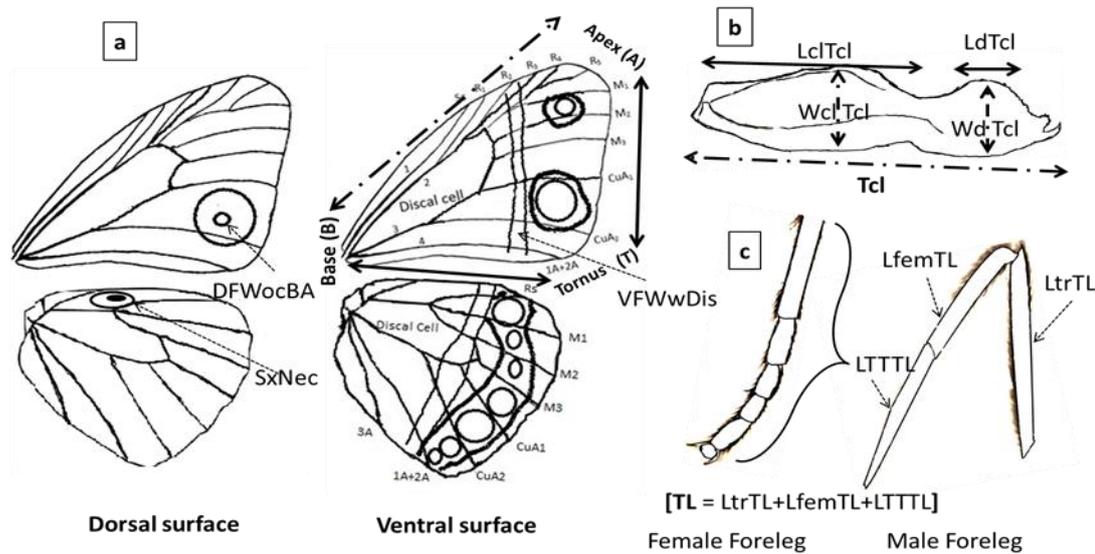


Figure 1: Morphometric measurements. (a) Wing characters: BA: forewing length base to apex; BT: forewing length base to tornus; TA: forewing length tornus to apex; DFWocBA: diameter of dorsal forewing ocellus; SxNec: ratio of sex brand to necreous patch; VFWwDis: ventral forewing discal band. (b) Genital characters: LclTcl: length of clasper; LdTcl: length of dorsal process; Tcl: total calasper length; WclTcl: width of clasper; WdTcl: width of dorsal process. (c) Foreleg characters: LfemTL: length of femur; LTTTL: length of tibia and tarsus; LtrTL: length of trochanter; TL: total length of foreleg.

RESULTS

Five PCs were obtained from the PCA of wing variables from which 11 variables were selected as significant (>60% loadings). Two PCs each resulted from the analysis of foreleg and genital variables. One-way ANOVA results (Table 1) showed that the first four PCs of wing variables (cumulative frequency of 57.4%) and PC2 (34.6% variance) of foreleg variables were significantly different between climatic zones ($P < 0.05$). Table 1 also reports the PCs and the morphometric variables that displayed a significant difference between the Zones by *post-hoc* analysis.

Table 1: Principal Components (PC) and morphometric variables that displayed a significant difference between climatic zones by ANOVA and *post-hoc* analysis.

One-way ANOVA			Post-Hoc Test			Variable	Post-Hoc Test		
PC	F	P value	Zones	Mean Difference	P value		Zones	Mean Difference	P value
PC1 Wing	8.458	0.001	D-W	0.838	0.006	TA	D-I	0.984	0.01
			W-I	1.055	0.005	BA	D-W	-0.795	0.013
PC2 Wing	4.451	0.016	D-I	1.019	0.027	VFWwDis DFWocBA	Not significant		
			D-W	0.685	0.046				
PC3 Wing	4.551	0.014	D-I	1.138	0.011	SxNec	D-I	-1.286	0.002
						VHW5ocT	D-W	-0.817	0.039
PC4 Wing	4.983	0.01	D-W	0.854	0.008	DFWcol	Not significant		
						VFWcol	D-W	0.707	0.033
PC2 Foreleg	3.655	0.031	D-W	-0.698	0.045	LTTTL	Not significant		
						LfemTL	D-W	-0.842	0.008

(D-W: Dry & Wet Zones, D-I: Dry & Intermediate Zones, W-I: Wet & Intermediate Zones)

Wing length and wing pattern elements: Wing lengths of Wet Zone populations (PC1wing) and wing pattern elements of Dry Zone populations (PC2wing) were significantly different from other climatic populations (Table1). Variation of wing lengths (BA, $F_{(2, 63)}5.079$, $P < 0.01$ & BT, $F_{(2, 63)}4.794$, $P < 0.01$) showed that larger wing lengths were found among the Wet Zone populations and smaller wing lengths predominate the Dry Zone. A fitted linear regression line ($y=0.695x$, $F_{(2, 63)}60.046$, $P < 0.0005$) expressed a positive, significant relationship between the two zones explaining 48% of variation. Wing pattern elements quantified by PC2wing indicated that Dry Zone populations possessed larger DFWocBA (mean 0.04 ± 0.02 mm) and broader VFWwDis (mean 0.03 ± 0.01 mm) compared to the other two zones.

Secondary sexual characters: Ratio of SxNec (PC3wing) distribution within the three climatic zones illustrated larger ratios in the Dry Zone in comparison to the Wet and Intermediate Zones. The greatest difference was between the Dry and Intermediate Zones (mean difference -1.286 , $P < 0.002$). Dry Zone populations thus consist of larger sex brands (mean 2.62 ± 0.45 mm) on smaller nacreous patches (mean 4.28 ± 0.53 mm) with the reverse found in the Wet and Intermediate Zones.

Wing colour: Both dorsal and ventral forewing colour expressed by PC4wing was significantly different between Wet and Dry Zone populations and indicates that Dry Zone populations consist of darker dorsal (DFWcol) and ventral (VFWcol) forewing colours (DFWcol: mean 49.24 ± 7.57 , VFWcol: mean 42.06 ± 5.88) compared to that of Wet Zone populations (DFWcol: mean 44.05 ± 7.97 , VFWcol: mean 35.59 ± 8.82). Mean distributions of VFWcol ($F_{(2, 63)}4.114$, $P < 0.02$) between the Dry and Wet Zones depict lighter wing colours in the Wet Zone (mean 35.59 ± 8.82 mm) and darker in the Dry Zone (mean 42.06 ± 5.88 mm). Hence, the Dry Zone populations consist of darker coloured VFWs of smaller size.

Foreleg Characters: Variations of foreleg parameters (PC2foreleg) were significantly different between Wet and Dry Zone populations. Variations of LfemTL showed a similar pattern to that of wing length with larger femur lengths found in the Wet Zone populations (mean 0.30 ± 0.02 mm). This contributes to total size of the foreleg where Wet Zone populations possessed longer forelegs.

DISCUSSION

The investigations conducted in this study reveal that butterfly populations in the Dry Zone are darker and smaller in size compared to those lighter and larger sized adults from the Wet Zone. Genital characters did not display significant differences between climatic regions. These results thus point to an association existing between the climatic zone and the wing and foreleg character elements of *M. perseus* populations. Though presence of wet and dry forms had been reported for *M. perseus* in Sri Lanka, geographical variation in morphometric characters of adult populations had not been established previously.

Temperature, photoperiod, humidity, food plant and microhabitat conditions are some of the factors thought to induce seasonal phenotypic variation in adult butterflies (Braby 1995) and several hypotheses have been put forward to explain the exhibited seasonal phenotypic changes. For example, it is proposed that seasonal forms may be increasing survival through optimizing thermoregulation in response to changes in environmental temperatures or they may be increasing survival by avoiding predation by matching the resting background colouration through crypsis (Braby 1995, Kemp & Jones, 2001, Kingsolver & Wiernasz, 1991). Studies have also shown that populations in different climatic regions differ in the phenotypic variation induced by environmental stimuli.

Sri Lanka is traditionally designated into the three climatic zones mainly based on rainfall regimes. The Wet Zone receives relatively high mean annual rainfall over 2,500 mm without pronounced dry periods. The Dry Zone receives a mean annual rainfall of less than 1,750 mm with a distinct dry season from May to September. The Intermediate Zone receives a mean annual rainfall between 1,750 to 2,500 mm with a short and less prominent dry season. Temperature does not vary very much in the three zones, as differences observed in temperature over Sri Lanka are mainly due to altitude rather than latitude. However, the microhabitat temperature in the Dry Zone can be as high as 37°C in the dry season. Similarly relative humidity also varies across the zones. It is unclear whether the variations observed in our study among the populations of *M. perseus* morphometric characters between the climatic zones are due to selective processes influenced by these climatic factors. However, to respond to the variable environment, it is possible that a combination of thermoregulatory, predator escape or other selective strategies induce phenotypic variations. Alternatively, some of the phenotypic differences such as wing size may be influenced by variations in rainfall pattern affecting food availability as reported for *M. sirius* (Braby 1995). It is possible that during the 5-month long dry period in the Dry Zone there are shortages of food plants for larvae and as a result populations of smaller sized butterflies may be developing. In comparison, the other two zones lacking prominent dry spells may not be facing food shortages, thus attaining larger adult sizes. The presence of more prominent visual and olfactory cues (larger sex brands) on Dry Zone butterflies may be implying an importance of these characters for mate attraction as suggested by Costanzo and Monteiro (2007) for the *Bicyclus anynana* butterflies.

This study demonstrates the presence of variation in *M. perseus* wing and foreleg morphometric characters between populations found in the different climatic regions across Sri Lanka; however, we have not been able to determine the factors responsible for the differences. More detailed studies are therefore being conducted to establish whether these phenotypic differences are influenced by climatic factors such as temperature, humidity and rainfall patterns and thus reveal any evidence for local adaptation of populations to the regional climate or whether these differences are explained by non-selective processes.

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INFLUENCE OF A QUADRUPOLE ION GUIDE ON ION IMAGING IN MALDI ORTHOGONAL QqTOF MASS SPECTROMETRY

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INTRODUCTION

A mass spectrometer determines the mass of a molecule by measuring the mass-to-charge ratio (m/z) of its ion. In the analysis of complex samples, such as biological tissues, the coupling of high vacuumed matrix assisted laser desorption/ionization (MALDI)[1,2] source with the time-of-flight(TOF) [3]mass analyzer is one of the most versatile combination to desorb and ionize molecules in a wide mass range with excellent sensitivity. However due to the direct coupling of MALDI ion source with a TOF mass analyzer, and hence the high vacuum condition in the source region, the mass spectral performance degrades. A decoupled elevated pressure MALDI ion source with a TOF analyzer was introduced by K.G. Standing and co-workers, at the University of Manitoba [4] using an orthogonal quadrupole-TOF technique (QqTOF).In this instrument, the quadrupole maintains the vacuum gradient between the high pressure MALDI source and the vacuumed TOF analyzer and the cooling gas inside it converts the pulsed ion packets into quasi-continuous narrow beam.

Imaging mass spectrometry (IMS) is a new technique that reveals relative molecular distribution in a two-dimensional space with micro meter scale spatial resolution on the surface of a sample (tissue section). The use of MALDI for imaging mass spectrometry, has recently attracted much interest, starting with the pioneering work of Caprioli *et al* [5] in 1997, but the field has grown dramatically in the last few years. Most research in MALDI imaging involved a time consuming sampling technique (spot-to-spot laser raster sampling) coupled with axial-injection TOF instruments. Recently, orthogonal QqTOF mass spectrometry has been used with continuous laser raster sampling to speed up the MALDI imaging process with a higher spatial resolution and sensitivity. In this process, the laser moves continuously over the sample on raster lines while firing. The ion packets, produced by each laser pulse, correspond to consecutive locations of raster lines on the sample surface travel inside the quadrupole one after the other. When the laser is firing at a higher frequency, to make the imaging process faster, there is a possibility to overlap the consecutive ion packets at the quadrupole, degrading the ion images. This paper studies the overlapping of ion packets with the laser frequency of MALDI ion source for different molecular weights.

METHODOLOGY

Angiotensin (726 Da), Substance P(1347.63 Da) and Melittin (2846.46) compounds were purchased from Sigma-Aldrich Co. (Oakville, ON, Canada) and diluted in water/ acetonitrile/ TFA, 50:50: 0.1% solution to make 10^{-6} M concentration and an equal volume of each solution was mixed together. The DHB matrix was diluted in the water/ Acetonitrile/ TFA, 50:50: 0.1% solution to make a 20 mg in 1ml solution. An equal volume of matrix and the prepared solution mixed together and a 5 μ l volume was applied on the MALDI target for analysis. The experiment was carried out with the MALDI orthogonal QqTOF imaging mass spectrometer which consisted of a segmented quadrupole (Figure 1). A N_2 laser (model VSL-337ND, Laser Science Inc337 nm, 20Hz) up to 20 Hz and Nd-YAG laser-355 nm(model S355B-100Q, JDSU- 50 μ J per pulse (8-10 ns),200 kHz) above 20 Hz frequency that was

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coupled with a optical fiber of 50 μm in diameter (QMMJ-55-UVVIS-50/125-3-2, OZ Optics LTD, Numerical aperture 0.22) was used to ablate the sample.

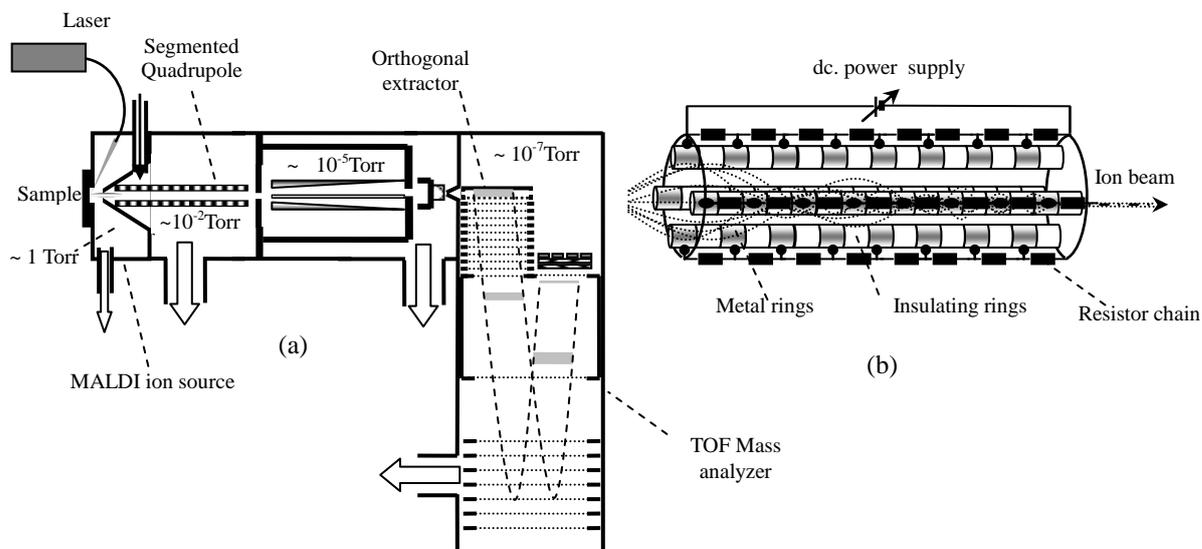


Figure 1 : Schematic diagram of (a) a MALDI orthogonal Qq TOF mass spectrometer and (b) a segmented quadrupole ion guide[6,7]

The quadrupole consisted of four metal/Teflon rods of 25 cm in length and 3 mm in diameter. Each rod was made of 26 metal and Teflon pieces arranged alternatively and each consecutive metal piece of each rod was externally connected with a series of resistors and the end was connected to a low voltage variable dc power supply, to maintain an axial voltage gradient inside the quadrupole. Typical mass spectra and total ion count with the time were collected by moving the laser on the sample surface for different laser frequencies.

RESULTS AND DISCUSSION

The following figure shows the typical mass spectrum and the total ion count with the scanning time for the mixture of standard masses (726, 1347 & 2846 Da). The sample was ablated by laser pulses at a low rate (about 5 Hz) maintaining the axial voltage gradient of the quadrupole at 4 V/25 cm .

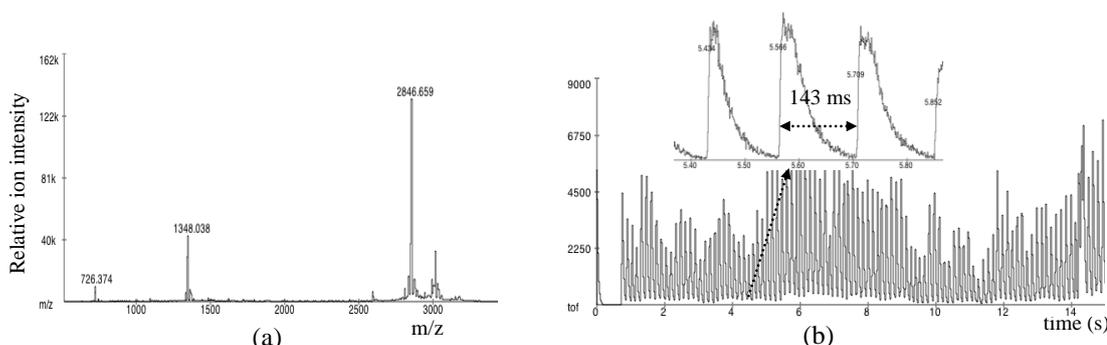


Figure 2 : (a) Typical mass spectrum, the 1st isotropic peak of single charged ions corresponding to the standard masses (726, 1347 & 2846 Da), (b) the total ion count with the

sample scanning time. The laser frequency was at ~ 5 Hz and the quadrupole axial voltage gradient was maintained at 4 V/25 cm.

Each pulse shown in figure 2(b) represents the total ion distribution at the ion detector of the mass spectrometer. Figure 3 indicates the shape of ion pulses corresponding to three different types of molecular ions contained in the sample mixture.

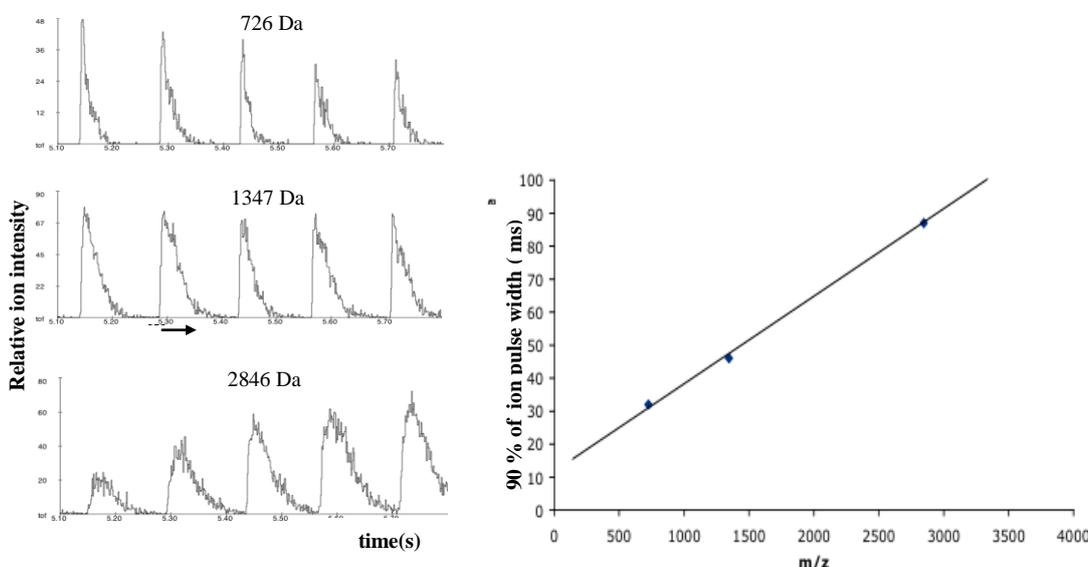


Figure 3: Variation of ion pulse width against different masses under a ~5 Hz laser repetition rate and a 4 V/25 cm axial voltage gradient in the segmented quadrupole

According to the data shown in figure 3, the transient time of each ion in the quadrupole region depends on the mass of its ion. The 90% of ion pulse width was calculated considering the 90% of total ion count from the rising edge.

To understand the overlapping of ion packets at the high frequent laser ablation in continuous laser raster sampling in imaging mass spectrometry, the following data was collected for different laser firing frequencies at the MALDI elevated pressure ion source in the orthogonal QqTOF mass spectrometer.

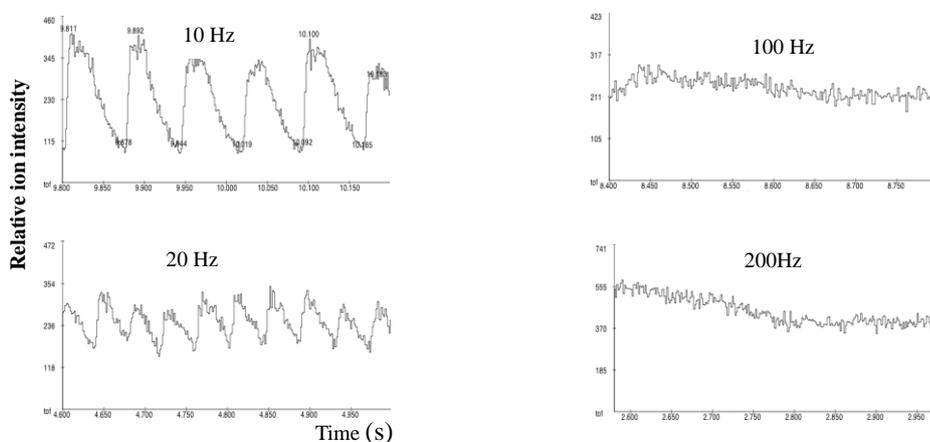


Figure 4: Variation of ion pulse width for different laser frequencies (N₂ laser for 10, 20 Hz and Nd-YAG laser for 100, 200 Hz) for the axial voltage gradient of 4 V/25 cm in the segmented quadrupole in the orthogonal QqTOF imaging mass spectrometer.

According to the above figures, the ion pulses are overlapping increasingly for the higher laser frequencies performing quasi-continuous ion beam.

CONCLUSIONS/RECOMMENDATIONS

Even though the width of a laser pulse is about a few nanoseconds at the elevated pressure MALDI source, the width of an ion pulse is about a few tens of microseconds detected at the detector in a QqTOF orthogonal injection mass spectrometer. When the laser frequency is higher than 100 Hz, the ion pulses are almost overlapped with the adjacent pulses and it is mostly due to the heaviest ion in the spectrum.

According to the total ion count with the scanning time for each laser pulse, the front edge of the pulse shows a rapid increment and then decays exponentially. Therefore the broadening of ion pulses mainly depend on the back edge of a pulse.

The following hypothetical figure depicts the overlapping of adjacent ion pulses due to a higher laser frequency and the broadening of ion packets at a quadrupole.

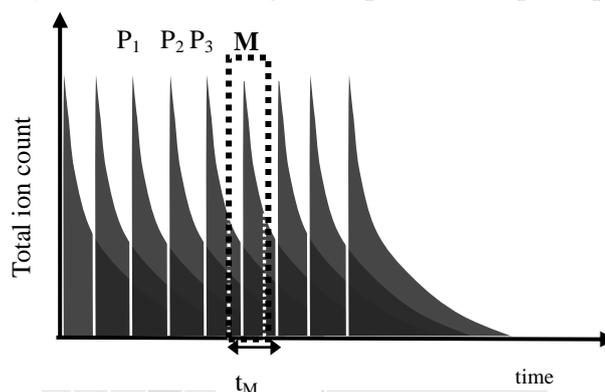


Figure 5: Overlapping of ion packets at the quadrupole region (M- Major ion packet , P₁ , P₂ and P₃ - adjacent ion packets)

In the above figure, as an example, the t_M time period is selected as the pixel size of the corresponding ion image, covering the M major ion pulse (dominant peak of the relevant pixel). Then P₁, P₂ and P₃ are the adjacent pulses that affect the pixel of the image corresponding to t_M . According to the experiment's results, at a higher frequency of laser, due to the ion pulse overlapping, the selected pixel in the image does not purely represent the molecular distribution of a corresponding location of the sample. Therefore it is recommended to use a technique for ion transmission in between the elevated pressure MALDI ion source and a high vacuumed TOF analyzer without ion packet broadening to avoid degrading the spatial resolution in imaging mass spectrometry.

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MOLECULAR AND AGRO-MORPHOLOGICAL AFFINITIES AMONG WEEDY, WILD AND CULTIVATED RICE VARIETIES IN DIFFERENT CLIMATIC ZONES OF SRI LANKA

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INTRODUCTION

Weedy rice (*Oryza sativa f. spontanea*), widely distributed in rice growing areas in the world, is a weedy relative of cultivated rice and has become a major threat. This weed is reported particularly in South and South-East Asia, South and North America, and Southern Europe (Mortimer *et al.*, 2000; Chauhan and Johnson, 2010; Chauhan, 2012) and leads to high production costs due to a yield reduction (Azmi and Karim, 2008). In general, weedy rice (WR) populations reduce farmers' income both quantitatively through yield reduction and qualitatively through lowered commodity value by staining the grains with undesirable pericarp color (Mortimer *et al.*, 2000). At present, the weedy rice has reached a considerable competitive level of infestation threatening the sustainability of rice cultivation especially in Asian countries. WR was first reported in Sri Lanka in 1992 from Ampara District and presently is spreading into many areas of the country. At present WR is in varying population densities, in all agro-ecological zones of the country (Abeysekara *et al.*, 2010). The term "weedy rice" generally includes all the species of the genus *Oryza* which conspecific with rice and is in rotation with rice weeds. WR populations have been reported in many rice-growing areas in the world where the crop is directly seeded (Ferrero and Finassi, 1995). A number of factors contribute to the WR occurrence such as gene flow between wild and cultivated *Oryza japonica* types, old rice varieties becoming feral, as well as crosses between cultivated rice and wild rice such as *O. nivara* and *O. rufipogon* (Marambe and Amarasinghe, 2000). Most of the WR contains AA genome, because they have evolved from the cultivated rice and have intermediate characteristics between cultivated and wild. The most widely documented WR is *O. sativa* in all rice growing regions, especially, in Asian countries. Apart from "AA genome *Oryza* species", only three other *Oryza* species have been reported as weeds in rice fields: *O. latifolia* in Central America, *O. officinalis* in the Philippines and *O. punctata* in Africa (Vaughan *et al.*, 2005). Many WR plants share most of the features of the two cultivated species *O. sativa* and *O. glaberrima* (Khush, 1997). However, at seedling stage, WR plants are difficult to distinguish from the crop (Hoagland and Paul, 1978). The identification of WR bio-types using agro-morphological characters is the main problem that is faced by farmers and agronomists. The limited knowledge on genetic diversity and the origin of WR along with the mechanisms of distribution preclude the controlling and managing WR. Therefore, depth studies on WR populations in different eco-climatic zones are required to determine and compare the molecular relationships. In this regard, DNA based markers and several different DNA fingerprinting techniques such as Random Amplified Polymorphic DNA (RAPD), Amplified Fragment Length Polymorphism (AFLP) and microsatellites are of importance in identification of WR. The DNA fingerprinting techniques has been used to identify relationships among the crop wild relatives and to determine the diversity of DNA in a range of crops including rice (Mackill, 1995). The main objective of the present study was to determine the molecular and agro-morphological affinities among weedy rice bio-types, wild and cultivated rice varieties found in three climatic zones (Wet, Intermediate and Dry zones) in Sri Lanka using microsatellite markers.

MATERIALS AND METHODS

Seeds of Wild rice (*O. nivara*), cultivated rice varieties (Bg379-2, Bg358, At362) and presumed WR bio-types were collected from three different climatic zones: Matara (WL4) in wet zone, Kurunegala (IL1) in Intermediate zone and Puttalam (DL3) in dry zone of Sri Lanka. Collected seeds were subjected to dormancy breaking treatments and sown in plastic trays in a plant house at the Open University of Sri Lanka, Nawala. Agro-morphological characters of selected wild, weedy and cultivated varieties were measured/scored. Total genomic DNA was extracted from 7-day old seedlings of the WR, wild rice and cultivated rice varieties using Ceygen Plant total DNA purification kit.

SSR primer pairs (RM11, Forward-TGTA AACGACGGCCAGTTCTCTCTTCCCCCGATC and Reverse – GTTCTTATAGCGGGCGAGGCTTAG) were selected from Rice Genes data base and labeled using FAM, NED, PET, VIC (Schuelke, 2000).

PCR was carried out with denaturation period of 1 min., at 95 °C followed by 30 cycles of 30 seconds at 95°C, 30 s at 55 °C and 1 min. at 72 °C subsequently 1 min for the 1st part of the PCR cycles, then added 0.5 µl of labeled primers and 10 cycles were performed followed by 30 seconds at 95°C, 45 s at 53 °C and 45 s at 72 °C subsequently 10 min for the final extension. Reactions were carried out in a volume of 30 µl of which consist 1 x buffer, 1mM dNTPs, 2µM SSR primers, 2mM MgCl₂, 50 ng of genomic DNA and 0.5 U of Taq polymerase. Fragment analysis was performed using GENE MAPPER software and identified different peaks.

In addition, base pairs representing peaks in the electrophorograms representing alleles of agro-morphological traits were tallied with the cultivated, wild and WR bio-types in the data set. The number of variables in the data set was reduced to five variables (Panical type, Awn colour, Lemma&Paleacolor and Leaf Blade width), using classification and regression tree analysis and the chosen variables were used to cluster the base pairs and the rice genotypes.

RESULTS AND DISCUSSION

The microsatellite (fragment) analysis using capillary electrophoresis resulted in different peaks representing weedy rice (X), wild rice (Z) and cultivated rice (Y) collected from different climatic zones representing dry, wet and intermediate zones of Sri Lanka. The electrophorogram generated by fragment analysis indicated that WR closely associated with wild rather than cultivated rice varieties in the Intermediate zone. Results obtained from the Intermediate zone (Figure 1) shows a close relationship among weedy bio-type 1 (X1) and cultivated rice (Y, Bg358) variety and two different WR bio-types representing different peaks in Figure 1. However, compared to the bio-types of WR (X3 and X4) in the Wet zone, a close relationship to wild rice variety (Z – *O. nivara*) is indicated. The cultivated rice variety, (Y1, Bg379-2) seems to be distantly related with the two WR bio- types (X3 and X4). When considering the Dry Zone (Figure 3), two different WR bio-types (X5 and X6), wild rice (Z) and cultivated rice variety (Y3, At362) has not exhibited any close relationship with each other.

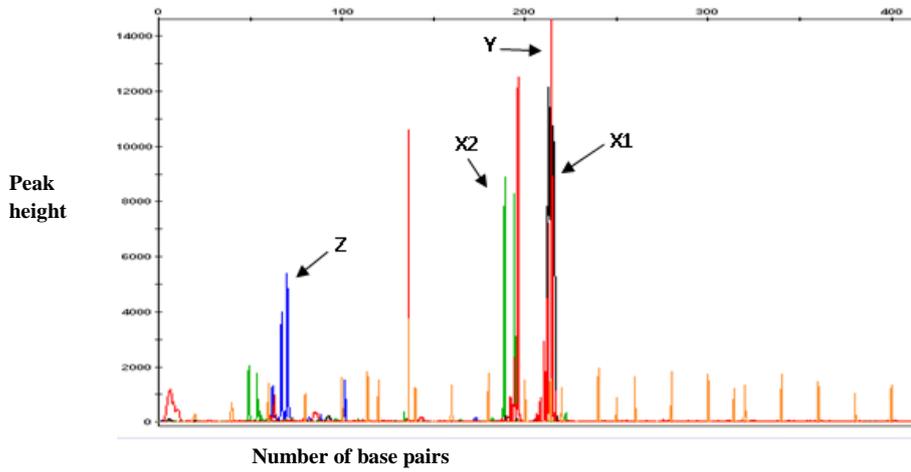


Figure 1.Electropherogram of Wild (Z), Weedy (X1, X2) and Cultivated rice variety(Y) in Kurunegala (IL1) - Intermediate Zone of Sri Lanka

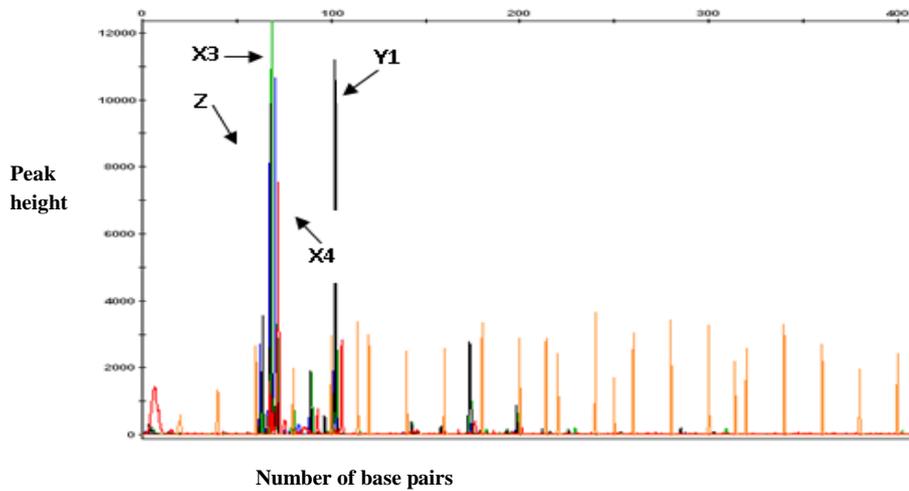


Figure 2.Electropherogram of Wild (Z), Weedy (X3, X4) and cultivated rice variety (Y1) in Matara (WL4) - Wet Zone of Sri Lanka

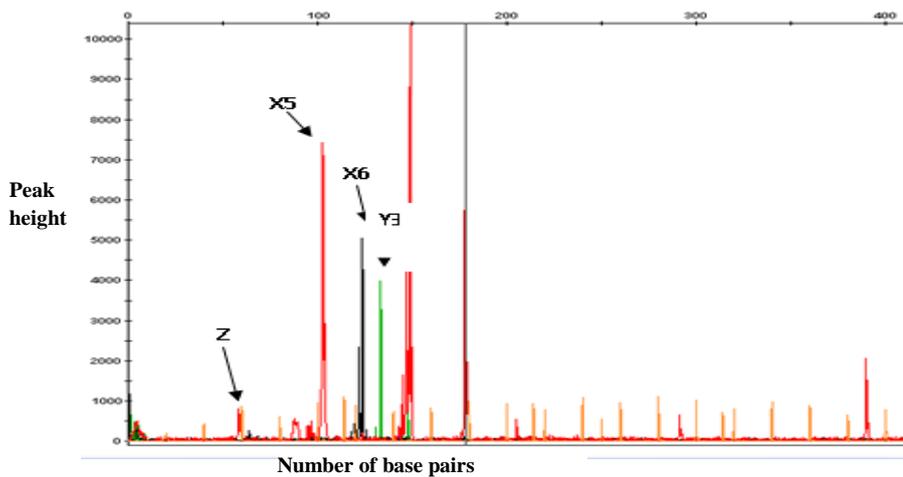


Figure 3.Electropherogram of Wild (Z), Weedy (X5, X6) and cultivated rice variety (Y3) in Puttalam (DL3) - Dry Zone of Sri Lanka

The clustering pattern of base pairs of rice genotypes and corresponding morphological types were given in Figure 4. The smaller base pairs occur in wild rice irrespective of the ecological provenance of origin. The wild rice bio-type collected from Intermediate zone falls into a separate cluster and the rest of the base pairs represented a comparatively large cluster. Similarly the clusters characterized by the agro-morphological features also indicated the same pattern of clustering. According to the pattern of clustering in the dendrogram, the cultivated rice varieties included within the larger cluster associating the WR rice bio-types. The patterns reflected in the dendrogram suggest that there may be a close relationship between the agro-morphological features interest and the base pairs in the rice genome.

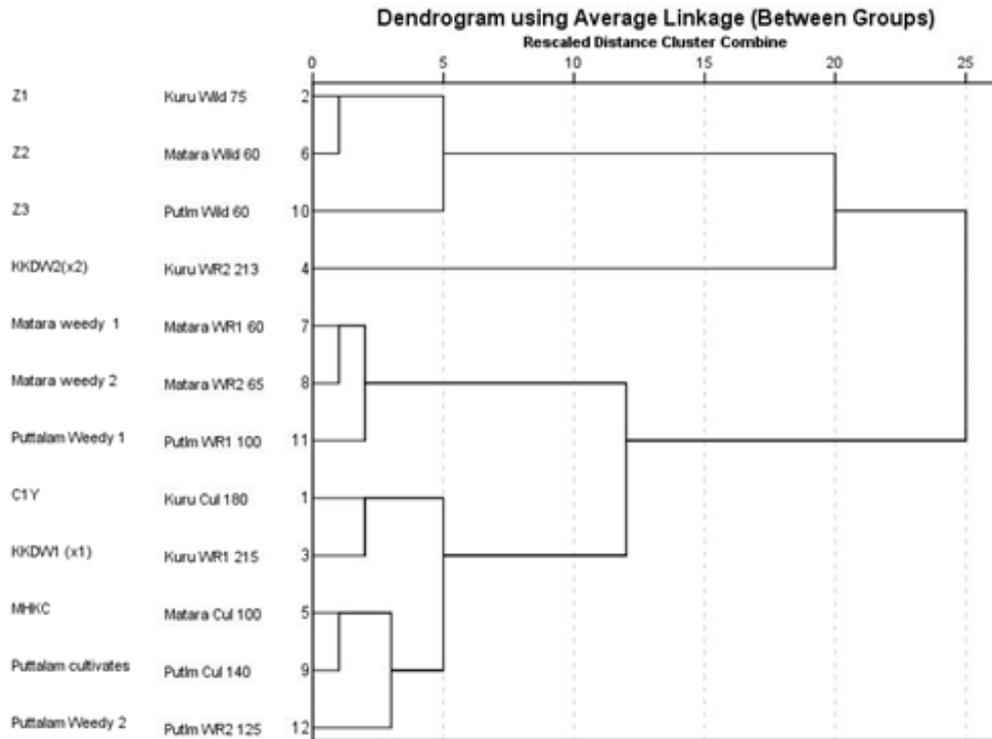


Figure 4. Clustering pattern of base pairs of wild, weedy and cultivated rice genotypes and corresponding Agro-morphological traits (Z1- Kurunegala wild, Z2- Matara wild, Z3- Puttalam wild, X2- Kurunegala weedy 2, Matara WR1-Matara weedy 1, Matara WR2- Matara weedy 2, Putlm WR1- Puttalam weedy 1, C1Y- Kurunegala cultivated 1, X1- Kurunegala weedy 1, MHKC- Matara cultivated, Putlmcul- Puttalam cultivated, PutlmWR2- Puttalamweedy 2)

CONCLUSIONS / RECOMMENDATIONS

The molecular analysis indicated that weedy rice bio-types have shown an intermediate relationship to those wild and cultivated rice varieties found in different agro-ecological zones of Sri Lanka. Higher genetic variation of WR bio-types occurred in the dry zone of the country. The very close affinity of WR bio-types and the cultivated rice variety, Bg358 in the intermediate zone reflects the potential of the occurrence of a higher out-crossing ability between WR bio-types and Bg358. However, in the wet zone, there was a close molecular relationship among WR bio-types with wild rice (*Oryzanivara*) variety. This implies that the potential for the occurrence of a hybrid between wild and cultivated rice, which result in WR bio-types. Similar observations were reported by (Subasingheet *al.*, 2007) for the molecular characterization of WR in Sri Lanka with cultivated rice varieties, Bg300 and “KaluHeenati”, wild rice (*Oryzanivara*) and two WR accessions collected from Puttalam and Galle Districts. These observations revealed that different WR bio-types seem to have evolved either by natural hybridization between cultivated rice and compatible wild rice varieties, out-crossing between cultivated rice and weedy relatives or mutations occur in cultivated rice varieties

(Abeysekara *et al.*, 2010). However, it is necessary to carry out further studies to determine the affinity of WR with cultivated and wild rice varieties. Also, it is advisable not to cultivate the inbred rice varieties with a higher potential of out-crossing ability with WR to minimize further spreading and evolving of more WR bio-types.

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PERFORMANCE OF DYE-SENSITIZED SOLAR CELLS COATED WITH AN ULTRA THIN LAYER OF SiO₂ AROUND SnO₂ PARTICLES

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INTRODUCTION

Dye sensitized solar cells (DSSCs) are among the most promising types of solar cells that have power conversion efficiency exceeding 12% [1]. Compared with conventional silicon and other thin film solar cell technologies, DSSCs offer cost savings in materials and device processing. However, there are still some challenges to be met before DSSCs can truly compete with other solar cell technologies. Device efficiency, stability and lifetime are the key issues in this field of research. Utilization of mesoporous films made of nano particles of titania for DSSC is a breakthrough made by Gratzel and co-workers in 1991 to achieve high efficiencies [2]. After that, the possibility of achieving high efficiencies was realized even with other high band gap semiconductors such as SnO₂ and ZnO made in nano range [3, 4]. Due to many other reasons, TiO₂ is still considered the best among others for DSSCs due to the high effective mass of charge carriers in TiO₂ in quantum confinement. But DSSCs of high efficiencies comparable to TiO₂ films have been achieved with other high band gap semiconductor composites [5]. The improvement is principally accepted as the suppression of recombination of charge carriers due to passivation of trap states and charge carrier confinement.

In this study, we intend to suppress recombination of charge carriers in DSSCs by introducing an ultra thin layer of SiO₂ around SnO₂ crystallites. Materials such as Al₂O₃, MgO, and ZrO₂ have been used previously as barrier layers in DSSCs, but we could not find any record of the use of SiO₂ for the same [6]. But SiO₂ particles have been used as light scattering materials in TiO₂ films [7]. Here the thin barrier of insulating material enhances the lifetime of germinated charge carriers to improve the efficiency.

EXPERIMENTAL

Tin (IV) Oxide particles were coated with an ultra thin layer of silica by the following method. First, 0.5g of SnO₂ powder was weighted and grinded in an agate mortar with 2 ml of ethanol using a pestle. Then three drops of terphenol were added into that mixture and it was grinded well again. After that 2 drops of triton X-100 were added and the grinding continued. Then measured volumes of 0.5M sodium silicate 0.015 ml, 0.03 ml, 0.045 ml, 0.06 ml and 0.075 ml were added at a time to different SnO₂ samples that have been prepared as described above while grinding the paste further. After that, 1 ml of acetic acid was added drop wise to that mixture. Sodium silicate around the SnO₂ particles was supposed to turn into SiO₂ in the process of acidification.

The paste as prepared was used to coat films, by the doctor blade method, on conducting tin oxide (CTO) glass plates that were cut into the size of 1.5 x 1 cm². Prior to coating the films on the CTO glass, they were thoroughly cleaned by detergent, distilled water and acetone with ultrasonic agitation. Conducting tin oxide plates coated with SnO₂ films were dried on a hot

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plate heated up to 120 °C for 5 minutes. Then the films were sintered at 450 °C in a furnace for 30 minutes. When the films were cooled down to room temperature they were immersed in Ru-bipyridyl N-719 dye solution (0.5 mM in ethanol) for 12 h. After the dye adsorption, the films were rinsed with ethanol and sandwiched with platinum sputtered conducting glass substrates using clips. The capillary space between the two plates of cells were filled with electrolyte containing 0.5M potassium iodide, 0.05M iodine in a mixture of acetonitrile and ethylene carbonate 1:4 by volume. I - V characteristics of the cells were measured under the illumination of 100mWcm^{-2} simulated light source and computer controlled setup consisting of potentiostat/galvanostat. X-ray diffraction (XRD) patterns and SEM images were obtained for SnO_2 films with different SiO_2 percentages.

RESULTS AND DISCUSSION

Coating the ultra thin layer of insulator around semiconductor particles was supposed to suppress recombination of charge carriers injected into the bands of semiconductor by the excited dye molecules because they initially had sufficient energy to penetrate the thin insulating barrier. But they are prevented from leaking out after relaxation to the conduction band of the semiconductor as illustrated by the insertion in figure 1.

In this study we have investigated the possibility of using SiO_2 thin barrier around the SnO_2 particles to impede leakage of electrons for recombination processes which is one approach to increase the efficiency of DSSCs. Figure 1 shows the measured open-circuit photo-voltage (V_{oc}) and short-circuit photocurrent (I_{sc}) of DSSCs with different SiO_2 % by weight.

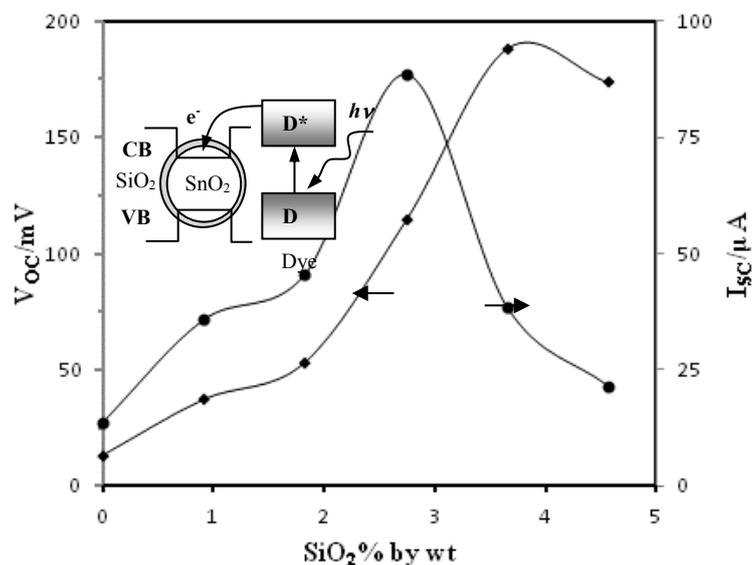


Figure 1: Open-circuit photovoltage (V_{oc}) and short-circuit photocurrent (I_{sc}) of DSSCs with different SiO_2 % in SnO_2 films,

Increment of SiO_2 % improves the coverage of SnO_2 particles with an ultra-thin layer of SiO_2 up to a particular level and beyond that limit contributes to the growth of the SiO_2 layer thickness around the SnO_2 particles. This is the reason why both the I_{sc} as well as the V_{oc} increase initially with the increment of SiO_2 % in the SnO_2 films of DSSCs. The increment of I_{sc} and V_{oc} is attributed to the suppression of recombination of injected electrons to the conduction band of SnO_2 by the photo-excited dye due to the buildup of ultra-thin layer of SiO_2 around SnO_2 particles. The highest photocurrent of DSSCs with the addition of 2.5 % of SiO_2 may have been achieved due to the perfect coverage of SnO_2 particles with SiO_2 ultra-thin layer. But V_{oc} continues to increase further up to 4% of SiO_2 in SnO_2 films. It is noticeable that the decrement of V_{oc} is not significant after reaching the maximum. However, further

increment of the thickness of the ultra-thin layer of SiO_2 caused both I_{sc} and V_{oc} to decrease.

The amount of dye adsorbed on the semiconductor film is also a detrimental factor on the performance of DSSCs. We have noticed that the dye adsorbed on SnO_2 films decreases with the increment of $\text{SiO}_2\%$. To quantitatively analyze it, we have desorbed the dye adsorbed on SnO_2 films with different $\text{SiO}_2\%$. This was done by allowing the films to adsorb dye for a determined period and completely desorbing the dye by immersing the dye adsorbed SnO_2 films in a 0.5 M KOH solution of known volume. The concentration of the dye in the KOH solution was estimated spectroscopically at the wave length of 550 nm. Figure 2 given below shows the deviation of dye adsorbed on SnO_2 films for different $\text{SiO}_2\%$.

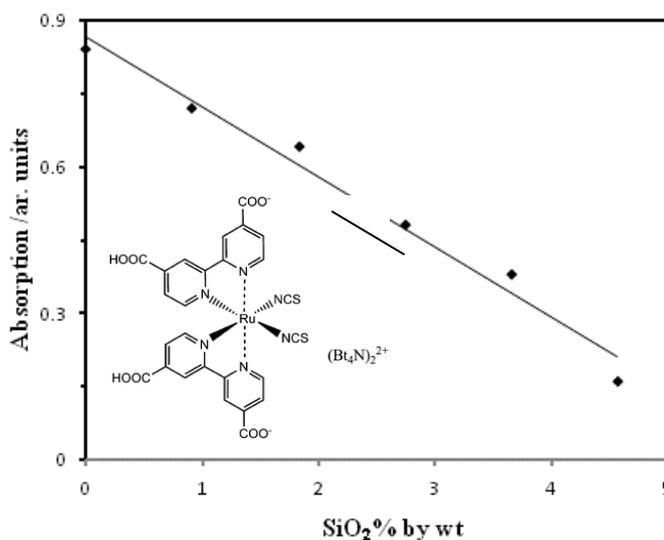


Figure: 2 Variation of dye adsorbed on SnO_2 films for different $\text{SiO}_2\%$ and insertion is the structure of the N-719 dye.

It is evident from the figure 2 that the dye adsorption on SnO_2 films decreases with the increment of $\text{SiO}_2\%$. This may affect adversely on photocurrent of DSSCs. Although dye aggregations on semiconductor films also caused decrease of the photocurrent, there should be an optimum amount of dye adsorbed on SnO_2 crystallites for efficient operation of DSSCs. The decrement of I_{sc} at higher SiO_2 percentages is a consequence of low dye adsorption on SnO_2 films. The adsorption of dye on SnO_2 films decreases with the increment of $\text{SiO}_2\%$ because of the acidity of SiO_2 which prevents chelation of N-719 dye on SnO_2 films by the carboxylic groups.

Analysis of XRD and SEM was also carried out to characterize the SiO_2 ultra-thin layer coated on SnO_2 particles. Figure 3 shows the SEM of SnO_2 film with 4.5% of SiO_2 . The resolution of the SEM images was not sufficient to identify the SiO_2 thin layer. But it can be seen that the SnO_2 particles are distributed in a wide range of particle sizes which also affect adversely on the performance of DSSCs.

The XRD pattern of the SnO_2 film with 4.5% of SiO_2 is given in Figure 4. There were no peaks that appeared for SiO_2 in the XRD pattern of the SnO_2 films. The inset in the figure 4 is the XRD pattern of SiO_2 powder obtained by acidification of Na_2SiO_3 with acetic acid and sintering at 450 °C for 30 minutes. It was found to be in amorphous form and most probably the SiO_2 around the SnO_2 was also amorphous. Because of the amorphous nature and low percentage, peaks of significance may not have been shown for SiO_2 in the XRD pattern.

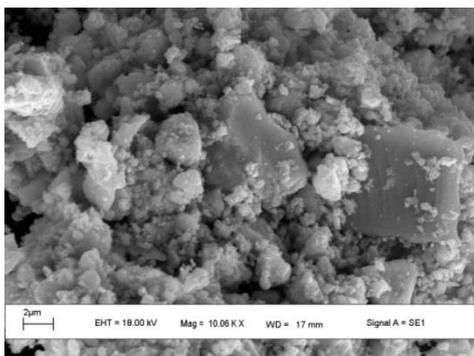


Figure 3: SEM image of SnO₂ film with 4.5% of SiO₂.

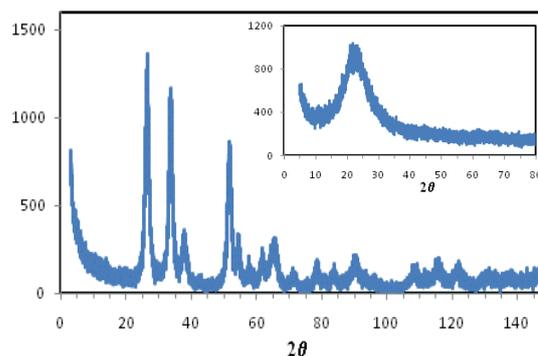


Figure 4: XRD pattern of the SnO₂ film with 4.5 % of SiO₂. Insertion is the XRD obtain only for SiO₂ powder.

CONCLUSIONS

Deposition of ultra-thin layer of SiO₂ on SnO₂ particles improve the performance of DSSCs. The reason for decrement of cell performance with higher percentages of SiO₂ is not only due to the barrier thickness, but also due to the low dye adsorption. It was observed by the SEM images that the particle size of SnO₂ is widely diverse. It is recommended to use uniform size of SnO₂ particles for better performance of DSSCs. Some chemical treatment may also be required to enhance the adsorption of dye on SiO₂ ultra-thin layer.

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DEVELOPING A SOCIAL INDEX TO DESCRIBE THE STANDARD OF LIVING IN THE COLOMBO MUNICIPAL COUNCIL AREA: A MATHEMATICAL MODELING APPROACH

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INTRODUCTION

Quality of Living (QOL) has been an object of many studies in different kinds of research classifications such as Community, Education, Environment, Health, Life satisfactions and Safety. Also, the notion of QOL has been discussed from different perspectives and interpretations. Expressions like "good city", "good place to live" and "good quality of living" involve conceptual perspectives that vary from person to person, place to place and at various periods of time. Quality of Living appears as a multidimensional concept. It is defined with respect to a variety of quantitative and qualitative criterion that change with the recognized values and wealth of society, culture, and time. The concept termed Arbitrary is one of the major concepts in describing QOL. Therefore Fuzzy Analytic Hierarchy Process (FAHP) theory provides an approach to deal with arbitrary and uncertain concepts. Fuzzy theory comes with the understanding that every vague phenomenon can be expressed in degree of membership. The construction of our composite indices for QOL via using the fuzzy theory follows two main steps. The first one concerns the definition of the membership function to each declared variable. While the membership function can take several formulations, we consider the "Fuzzy Analytic Hierarchy Process (FAHP)" as defined originally to weight each factor (Lelli, 2001). This study is based on the geographical area governed by the Colombo Municipal Council which consists of 15 zones. In related literature, the QOL context encompasses multi factors. The hierarchical structure, which is illustrated in table 1, was constructed using the existing approaches (Mercer, 2012) (Mittelhammer, 2003), (Kerce, 1992) with four main factors (Environment, Services, Housing and Recreation) and several sub factors as described in Table1.

Table 1: The hierarchical structure

The Hierarchical Structure of the Multi factors of Quality Of Living		
Main Factors	Sub Factors	Sub-sub Factors
Environment	Land	Population density
		Green coverage percentage
	Climate	Temperature
	Disturbances	Air Quality (CO Density)
Services	Education	Availability of schools
	Economic	Availability of banks
		Availability of markets
Health	Availability of Hospitals	
Housing	Percentage of slums	
	Percentage of luxury	
Recreation	The percentage of the total	
	Availability of Hotels/Movie	

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METHODOLOGY

Fuzzy Analytic Hierarchy Process (FAHP) is applied to determine the relative weights of the evaluation criteria in various multi-criteria decision-making (MCDM) problems (Han-Hsiang, 2008). It involves decomposing a complex MCDM problem into a hierarchy, assessing the relative importance of decision criteria, comparing decision alternatives with respect to each criterion, and determining an overall priority for each decision alternative and an overall ranking for the decision alternatives. However, when decision-makers' judgments are not crisp, and it is relatively difficult for them to provide exact numerical values, as in the example of performance appraisal process, the fuzzy logic that provides a mathematical strength to capture the uncertainties associated with human cognitive process can be used (Beskese, 2007). There are the several procedures to attain the priorities in FAHP. Chang's extent analysis is utilized in this research to determine the weights of main factors.

Membership Functions:

If a fuzzy set approach is to be used, membership functions have to be defined for all criteria. For a short mathematical exposition of the fuzzy sets principle, let us consider X as a set and x an element of X . A fuzzy subset P of X can therefore be defined as follows: $\{x, \mu_p(x)\}$ for all $x \in X$, where μ_p is a membership function which takes its values in the closed interval $[0;1]$. Each value $\mu_p(x)$ is the degree of membership of x to P .

Fuzzy Operators:

A fuzzy set is dilated by increasing the grade of membership of all elements that are partly in the set. The dilation of a fuzzy set A as denoted $DIL(A)$ and defined by,

$$U_{DIL(A)}(x) = U_A^p(x) \text{ where } p \text{ is the power of the operation.}$$

By using dilation operator, the algebraic product and Hamacher operator have been modified. The modified fuzzy set C , corresponding to the algebraic product, has the membership function

$$U_C(x) = U_A^{p_1}(x) \cdot U_B^{p_2}(x) \text{ where } p_1 \text{ and } p_2 \text{ are weights of each factor}$$

The modified fuzzy set H , corresponding to the Hamacher operator is characterized by

$$U_H(x) = \frac{U_A^{p_1}(x) \cdot U_B^{p_2}(x)}{p(1-p) \left[U_A^{p_1}(x) + U_B^{p_2}(x) - U_A^{p_1}(x) \cdot U_B^{p_2}(x) \right]} \text{ where } 0 \leq p, p_1, p_2 \leq 1$$

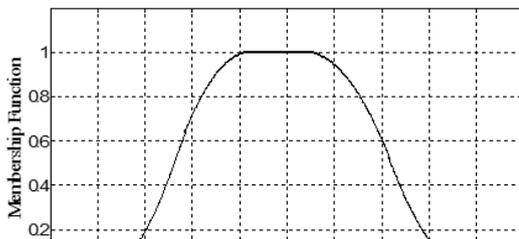
RESULTS AND DISCUSSION

The two methods which were used to aggregate the membership values, Modified Algebraic Product and Modified Hamacher Operator provided adequate results for the study. Both methods gave approximately similar results but the results provided by Modified Hamacher Operator indicated that the zone with the best quality of living in Colombo city is Colombo 07. The results provided by Modified Algebraic Product Operator indicated that the zone with the best quality of living in Colombo city is Colombo 08. The people in Colombo 07 and Colombo 08 may be enjoying the comfort of living conditions. The zones with the lowest ratings were Colombo 01 and Colombo 11, which areas are commercially important but proven not to have the best of living environments. Therefore, Modified Hamacher operator proved to be a convenient method in developing the indices. According to the weights using Fuzzy AHP, Housing has higher priority than the other factors. Recreation is the factor with the lowest priority. Thus the responses of the decision makers have a high impact on the final weight age given to these factors. Therefore decision makers should identify the factors according to importance appropriately.

Table2: Quality of living indices

Zones of Colombo	Using Modified Algebraic Product Operator		Using Modified Hamacher Operator	
	QOL Index	Ranking	QOL Index	Ranking
Colombo 01	0.0472	14	0.0748	14
Colombo 02	0.4427	05	0.5235	05
Colombo 03	0.4184	06	0.4389	06
Colombo 04	0.5871	03	0.6040	03
Colombo 05	0.3511	10	0.3995	07
Colombo 06	0.2364	12	0.2906	12
Colombo 07	0.7705	02	0.8498	01
Colombo 08	0.8073	01	0.8147	02
Colombo 09	0.4169	07	0.3752	10
Colombo 10	0.5157	04	0.5926	04
Colombo 11	0.0192	15	0.0280	15
Colombo 12	0.2971	11	0.3582	11
Colombo 13	0.3675	08	0.3937	09
Colombo 14	0.3624	09	0.3985	08
Colombo 15	0.1767	13	0.2469	13

An example for the calculations



By using this graph, the membership value of temperature of Colombo 07, i.e. 0.9444 is obtained. Likewise, the relevant membership values for the other variables are taken.

Figure 1: Membership Function of Temperature

Table3: Membership Values (Colombo 07)

Membership Values(Colombo 07)							
Environment		Services		Housing		Recreation	
Population density	1	Availability of schools	1	Percentage of slums	0.9278	The percentage of the total area devoted to Parks	0.9990
Green coverage percentage	0.2316	Availability of banks	1				
Temperature	0.9444	Availability of markets/ supermarkets	0.8243	Percentage of luxury apartments	0.4095	Availability of Hotels/Movie Theatre	0.8243
Air Quality (CO density)	1	Availability of Hospitals	0.2475				

Considering the power of operators as $\frac{1}{P_1} = 0.05, \frac{1}{P_2} = 0.17, \frac{1}{P_3} = 0.29, \frac{1}{P_4} = 0.49$ and $p=0.5$ following Quality of Living Indices are calculated using Modified Algebraic Product Operator and Modified Hamacher Operator.

Final Calculations:

By using Modified algebraic product

$$QOL = 0.6164^{0.05} \cdot 0.7687^{0.17} \cdot 0.6080^{0.29} \cdot 0.9075^{0.49} = 0.7705$$

By using Modified Hamacher operator

$$U_H^p(x_1) = \frac{0.6205^{0.05} \cdot 0.7791^{0.17}}{0.5 + (1-0.5)[0.6205^{0.05} + 0.7791^{0.17} - 0.6205^{0.05} \cdot 0.7791^{0.17}]} = 0.9363$$

$$U_H^p(x_2) = \frac{0.8311^{0.29} \cdot 0.9076^{0.49}}{0.5 + (1-0.5)[0.8311^{0.29} + 0.9076^{0.49} - 0.8311^{0.29} \cdot 0.9076^{0.49}]} = 0.9049$$

$$QOL = \frac{0.9363 \cdot 0.9049}{0.5 + (1-0.5)[0.9363 + 0.9049 - 0.9363 \cdot 0.9049]} = 0.8498$$

Table3: Aggregated Membership Values (Colombo 07)

Using Modified Algebraic Product Operator					Using Modified Hamacher Operator				
Environm ent	Servic es	Housi ng	Recreati on	QOL Index	Environ ment	Servic es	Housi ng	Recreat ion	QOL Index
0.7687	0.6080	0.6164	0.9075	0.7705	0.7791	0.8311	0.6205	0.9076	0.8498

CONCLUSIONS

This study compares the zones in Colombo city to rank them according to the quality of living index. Both qualitative and quantitative measurements were taken into consideration and simulated results obtained using a mathematical model. Fuzzy AHP technique was used to synthesize the opinion of the decision makers to identify the weight of each factor. Modified Hamacher operator proved to be a convenient method in developing the indices. Housing is the most important factor for quality of living. The study showed that the zones with the best quality of living in Colombo city are Colombo 07 and Colombo 08. Furthermore, the index can be extended to compare Quality of Living in each Districts or Province to ensure the quality of living in Sri Lanka, which can be useful to improve the socio economic conditions in the country and may be used for commercial purposes as well. The main factors of this study are limited to four; Housing, Environment, Services and Recreation. Thus an expansion of the scope could be used to enhance the accuracy and sensitivity of the index.

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DEVELOPMENT OF A FUZZY MODEL TO EVALUATE THE RISK OF INVASIVE PLANT SPECIES DUE TO DISPERSAL

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INTRODUCTION

Invasiveness of a species is recognized as the ability of a species to spread and establish beyond its origin while harming the biodiversity of the new environment [1]. Invasive Alien Species (IAS) are, therefore, considered as a serious threat to the existence of various ecosystems as they alter physical, chemical and biological components of the environment. The Risk Assessments (RA), the process of determining the likelihood in which a particular plant species becomes invasive, are currently available worldwide, which are found in qualitative or quantitative formats and have both advantages and disadvantages [2]. The RA includes a number of questions regarding the risk factors, which could demonstrate the invasiveness of plant species and scores, have predefined answers for each of those questions. Therefore, the main disadvantages are that the accuracy will depend strongly on the user and the likelihood of obtaining different scores by different users (individual bias). Mathematical models have provided opportunities to overcome such individual bias and to determine the effect of changes to which the system will be susceptible or amendable due to changes in the internal structure of the system. Fuzzy logic concepts provide opportunities to quantify or convert the parameters into a measurable scale and aggregate those fuzzified parameters to develop a model for situations that are described as vague or in imprecise terms, or for situations that are too complex or ill-defined to be analyzed by conventional mathematical or statistical tools. This work aims to convert some risk factors into a measurable scale using fuzzy membership functions and to develop a mathematical model in order to generate a numerical value for the overall invasion risk of a particular plant species using fuzzy set theory operators.

METHODOLOGY

In this section, we first introduce the risk factors that will be the parameters of this task.

1. Selected risk factors

According to the view of biologists, several factors affect the spread of invasive plant species, such as its ecology, establishment, and invasive potential and management aspects [2]. In conventional risk assessments, these factors are being considered. Moreover, the invasive potential could be further categorized into six groups, such as dispersal, growth, habitat-related, chemical-related, evolution, and man's influence on spread of the plants. Among these, dispersal was selected for this study, the most important four risk factors which are annual seed production, seeds per fruit, long distance dispersal strength and seeds viability, were considered. A database of 40 invasive and 10 non invasive plant species was developed using available information from trusted sources for the four risk factors mentioned above.

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2. Setting up fuzzy membership functions

In this subsection, we focused on developing membership functions that are continuous functions where the function values range from zero to one. In order to develop membership functions, the lower and upper boundary points were determined for the risk factors by considering their behavior with regards to invasive potential. When determining these boundary points, the following assumptions were made according to experts' suggestions:

Assumptions:

- The lower boundary point is the lowest possible value that has the minimum effect on the invasive potential of a plant species.
- The upper boundary point is the extreme value that has the maximum effect on the invasive potential of a plant species. For future tasks, in order to be compatible with any invasive plant other than those in the database, the defined the upper boundary has an unrealistic value.
- The invasive potential of plant species will increase when the values of risk factors increase from a lower boundary point to an upper boundary point.

Therefore, fuzzy Z shaped membership function was selected as the most appropriate membership function [4]. The Z-function is a spline-based function of x that is so named because of its Z-shape. The parameters a and b locates the extremes of the sloped portion of the curve as given by:

$$\mu_z(x, a, b) = \begin{cases} 1, & \text{for } x \leq a \\ 1 - 2 \left[\frac{(x-a)}{(b-a)} \right]^2, & \text{for } a \leq x \leq \frac{a+b}{2} \\ 2 \left[\frac{(x-b)}{(b-a)} \right]^2, & \text{for } \frac{a+b}{2} < x \leq b \\ 0, & \text{for } x \geq b. \end{cases} \tag{1}$$

2.1 Risk factor - Seeds per fruit risk factor

Defined the fuzzy Z- membership function for factor seeds per fruit as $U_A(x)$, where

$$U_A(x) = \begin{cases} 1 & \text{for } x \leq 1 \quad \leftarrow \text{lower boundary point} \\ 1 - \left[\frac{2(x-1)}{1000} \right]^2 & \text{for } 1 \leq x \leq 501 \\ 2 \left[\frac{(x-1001)}{1000} \right]^2 & \text{for } 501 < x \leq 1001 \\ 0 & \text{for } x \geq 1001 \quad \leftarrow \text{upper boundary point} \end{cases} \tag{2}$$

2.2 Risk factor –Annual seed production per m²

The fuzzy membership function defined for the factor annual seed production per m² as $U_B(x)$, where

$$U_B(x) = \begin{cases} 1 & \text{for } x \leq 100 \quad \leftarrow \text{lower boundary point} \\ 1 - \left[\frac{2(x-100)}{4999900} \right]^2 & \text{for } 1 \leq x \leq 2500050 \\ 2 \left[\frac{(x-5000000)}{5000000} \right]^2 & \text{for } 2500050 < x \leq 5000000 \\ 0 & \text{for } x \geq 5000000 \quad \leftarrow \text{upper boundary point} \end{cases} \tag{3}$$

2.3 Risk factor – Viability of seeds

The fuzzy membership function defined for factor seeds per fruit as $U_C(x)$, where

$$U_C(x) = \begin{cases} 1 & \text{for } x \leq 4 & \leftarrow \text{lower boundary point} \\ 1 - [2(x-4)/5996]^2 & \text{for } 4 \leq x \leq 3002 \\ 2[(x-6000)/5996]^2 & \text{for } 3002 < x \leq 6000 \\ 0 & \text{for } x \geq 6000 & \leftarrow \text{upper boundary point} \end{cases} \quad (4)$$

2.4 Risk factor – Long distance dispersal strength

- The data that we found for long distance dispersal strength was only the modes of dispersal, such as ‘whether the particular plant is dispersed by birds, water, animals or wind?’. This type of data was not easy to convert into a numerical scale because information on the exact distance that a plant can disperse its seeds by a specific mode is not available. Therefore, botanists’ expert opinions were considered in this regard.
- Thus, a ten-point scale was considered. In this scale, the point 0 was represented as the lowest long distance dispersal strength while point 10 was the highest distance dispersal strength (experts should consider this position as an unrealistically higher value for dispersal strength). A particular plant’s dispersal strength was marked along this scale. After collecting data from a group of botanists, the average value for the dispersal strength of each plant was calculated. Moreover, the conversion of these data into fuzzy variables membership function was defined as follows:

The fuzzy membership function defined for the factor long distance dispersal strength as $U_D(x)$, where [4]

$$U_D(x) = \begin{cases} 1 & \text{for } x \leq 0 & \leftarrow \text{lower boundary point} \\ 1 - [x/5]^2 & \text{for } 0 \leq x \leq 5 \\ 2[(x-10)/10]^2 & \text{for } 5 < x \leq 10 \\ 0 & \text{for } x \geq 10 & \leftarrow \text{upper boundary point} \end{cases} \quad (5)$$

3 Selecting the most suitable fuzzy operator

Here, we focused on selecting a suitable fuzzy set operator that models the risk of invasive alien plant species by aggregating the selected four risk factors. When selecting a suitable operator, we checked that the specific operator satisfies some properties, such as the possibility to allow for cumulative effects, interactions, and compensations between criteria [3]. Therefore, we found that the Yager operator [3] was the most suitable operator that is defined as follows:

- Y defines the intersection of two fuzzy sets A and B by

$$U_Y^p(x) = 1 - \min \left\{ 1, \left((1 - U_A(x))^p + (1 - U_B(x))^p \right)^{1/p} \right\}, \quad p \geq 1 \quad (6)$$

- $U_Y^p(x)$ is an increasing function of p and all intermediate situations can be modeled with the flexibility provided by the parameter.
- This operator satisfies all three properties, except in the case $p = \infty$.
- If the aggregate effect is high, the output takes values near the point zero and the effect is very low, and the output takes values near the point one

RESULTS AND DISCUSSION

In order to obtain numerical examples by applying the *Yager* operator, the plants in the database were categorized into three groups: Group 1: invasiveness mainly due to dispersal, Group 2: invasiveness due to dispersal and other factors, Group 3: non invasive plant species. Moreover, the fuzzy values of the selected four risk factors of plant species in each group were calculated using membership functions developed previously for each risk factor. For different p values, risk values were obtained for plant species in each group by using the *Yager* operator. Some results are displayed in the Table 1.

TABLE1 Risk values of plant species for different p values

Different groups of species	Plant species	Risk values		
		$p = 1.05$	$p = 30.5$	$p = 120.05$
Species' contribution to invasiveness mainly due to seed production (including the selected four risk factors)	<i>Lantana camara</i>	0.9351	0.9352	0.9352
	<i>Mimosa pigra</i>	0.6395	0.7408	0.7408
	<i>Ageratinariparia</i>	0.6794	0.6800	0.6800
Species' contribution to invasiveness due to seed production and vegetative means	<i>Sphagneticolatrilibata</i>	0.9968	0.9968	0.9968
	<i>Cuscutacampestris</i>	0.9948	0.9950	0.9950
	<i>Puerariamontana</i>	0.9918	0.9920	0.9920
Non invasive	<i>Cassia fistula</i>	0.9986	0.9988	1
	<i>Cissusrotundifolia</i>	0.9988	0.9988	1

According to the Table 1, the numerical values of the risk of plant species in the first group were low compared to the other two groups, as expected. The plant, *Lantana camara* had the risk score of 0.9352 ($p = 30.5$) since it is a highly invasive plant like *Ageratinariparia* which had the score of 0.68 ($p = 30.5$). The plant *Mimosa pigra* had the score of 0.6395, which exhibit higher risk than the other two plants in the same group. The plants in the second group are invasive, but not mainly from our selected four risk factors that had low contribution to invasiveness than the plants in the first group, and high contribution than the non invasive plants. According to the results, if a species is mainly invasive due to the selected four risk factors, the *Yager* operator generates the risk that has a low numerical value than the species that was invasive not only from the selected risk factors or was non invasive.

CONCLUSION

This study provides evidence that Fuzzy logic models can be used to quantify risk factors. The risk values obtained in fuzzy techniques fit biologically, as expected, but may not reflect the actual impact of risk factors. Also, certain issues can occur when we incorporate other factors into the model. These issues can be eliminated by improving the model according to experts' opinions and by evaluating the overall invasion risks of plant species.

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STUDY OF COPPER ION BIOREMEDIATION ACTIVITY OF THE UNKNOWN BACTERIAL (P) STRAIN

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INTRODUCTION

Bioremediation is a process of cleaning environmental contaminants using microorganisms (Vidali, 2001). It is an effective, affordable and environment - friendly biotechnological solution used for removing environmental contaminants such as hydrocarbon, heavy metal and other organic and inorganic pollutants.

Heavy metal pollution is a global problem that causes harm to fauna and flora (Gadd, 2000). Therefore, several approaches have been explored for heavy metal cleaning processes. Microorganisms play a major role in heavy metal bioremediation. Complex metabolic pathways of microorganisms are used to convert harmful pollutants into harmless compounds. Bacteria found in a heavy metal contaminated environment have evolved several mechanisms to survive under heavy metal stress (Rathnayake *et al.*, 2009). Some of these mechanisms, such as bio accumulation and reductive precipitation can be used in bioremediation. Studies of the bioremediation potential of bacteria are important in bioremediation applications.

The objective of this study was to identify the bioremediation potential of P bacterial strain on Copper (Cu^{2+}) ion, which was isolated from textile dyeing effluent.

METHODOLOGY

The previously isolated P bacterial strain, from a textile - dyeing effluent, was used for the present study. The P bacterial culture on Luria Bertani (LB) agar was prepared using preserved P strain in glycerol. LB broth cultures were prepared using isolated colonies (Affan *et al.*, 2009).

LB liquid medium with 1 ppm, 2 ppm, 3 ppm, 4 ppm, 5 ppm, 6 ppm, 7 ppm and 8 ppm Copper (Cu^{2+}) ion were prepared. These were filtered through an autoclaved 0.45 μm filter and 100 μl of overnight culture of the P strain was inoculated. Controls were prepared by using LB broth with 4 ppm of copper without the P strain (Ctl 1) and without Cu^{2+} ion and with the P strain (Ctl 2). All containers were air tight and incubated at room temperature for 8 days with continuous shaking at 150 rpm. Aliquots of 5 ml was taken out on day 1, day 2, day 3, day 6 and day 8 under aseptic conditions and the following procedures were carried out for each aliquot.

1. Measurement of optical density at 600 nm
2. Preparation of spread plates for 10^{-6} dilution and incubation at 37°C overnight.
3. Measurement of atomic absorption spectroscopy at 324.8 nm

RESULTS AND DISCUSSION

The growth curve that was obtained by optical density at 600nm is given in Figure 1. Optical Density was measured at 1:5 dilutions of every broth culture.

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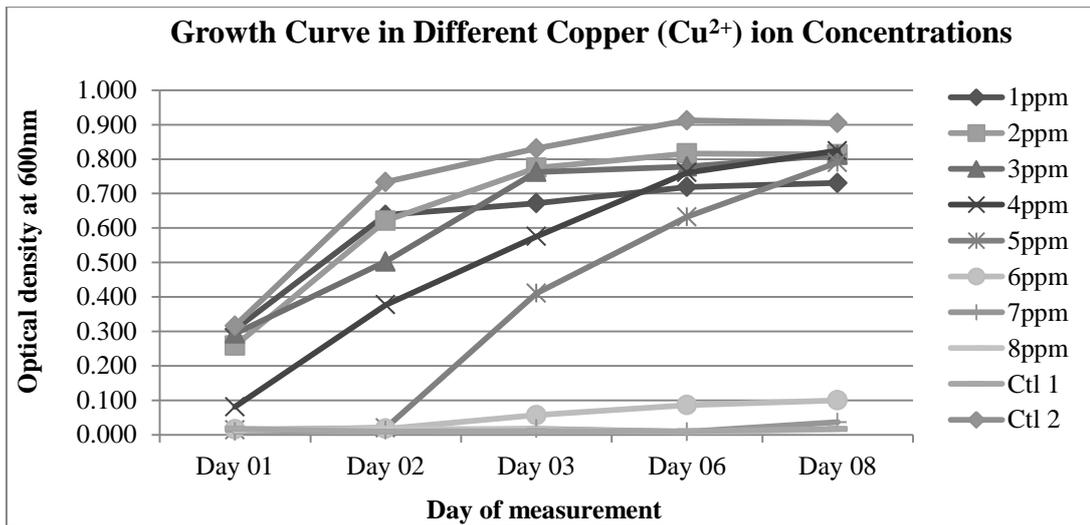


Figure 1: Growth curves of the P bacterial strain in LB broths with different Copper (Cu²⁺) ion concentrations. (Ctl 1- Abiotic control: LB broth with 4 ppm copper ion concentration with no bacterial inoculation, Ctl 2- Bacterial growth control: LB broth with bacterial inoculums with no copper ions.)

Figure 2 shows the growth inhibition of the P strain using Colony Forming Units(CFU) in 72 h broth cultures with different Copper (Cu²⁺) ion concentrations in LB broths. Growth was completely inhibited at 7 ppm Copper ion concentration. Slight growth could be seen in 6 ppm copper concentration and the Maximum Tolerable Concentration (MTC) for copper of the P strain was 6 ppm.

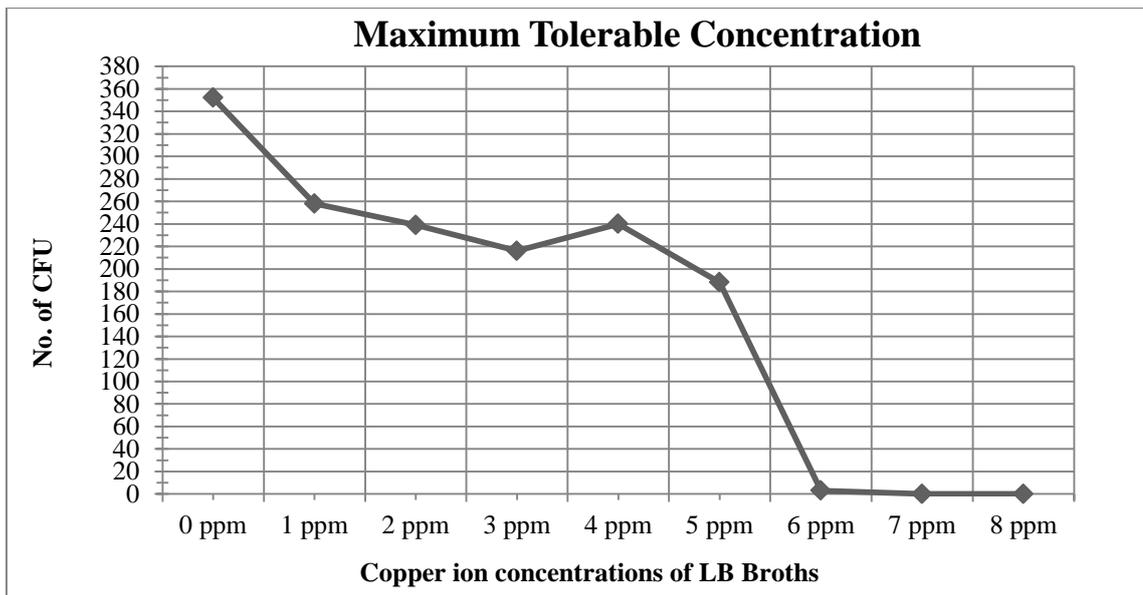


Figure 2: Growth inhibition of the P bacterial strain in LB broths with different Copper (Cu²⁺) ion concentrations (Maximum Tolerable Concentration).

Table 1 shows the Copper ion reduction during the experiment.

Table 1: Cu²⁺ ion concentrations taken from atomic absorption spectrophotometry during 8 days.

	Cu ²⁺ 1ppm	Cu ²⁺ 2ppm	Cu ²⁺ 3ppm	Cu ²⁺ 4ppm	Cu ²⁺ 5ppm	Cu ²⁺ 6ppm	Cu ²⁺ 7ppm	Cu ²⁺ 8ppm	Control 01	Control 02
Day 01	0.743	1.64	2.566	3.483	4.508	5.629	6.673	7.665	3.727	0.03
Day 02	0.391	1.104	1.549	3.232	4.266	5.628	6.713	7.839	3.902	0.005
Day 03	0.248	0.81	1.083	2.532	3.658	5.128	6.606	7.558	3.762	0.044
Day 06	0.099	0.268	0.304	1.241	1.002	4.795	6.735	7.867	3.861	0.011
Day 08	0.069	0.17	0.175	0.674	0.213	4.387	6.841	7.582	3.852	0.021

Figure 3 shows the reduction of Cu²⁺ ion concentration.

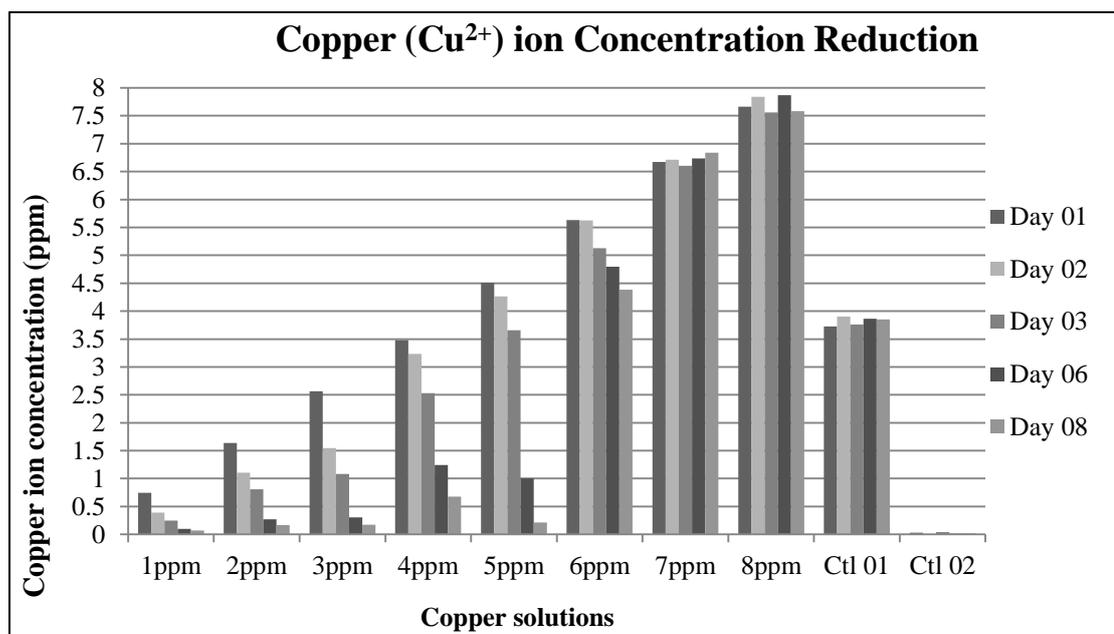


Figure 3. Reduction of Copper (Cu²⁺) ion concentration with time. Ctl 1- Abiotic control: LB broth with 4 ppm copper ion concentration with no bacterial inoculation, Ctl 2- Bacterial growth control: LB broth with bacterial inoculum with no copper ions.

A calculated 50% reduction of copper in the medium are shown in Table 2. Figure 4 shows the rate of Copper (Cu²⁺) ion decrease during 8 days. A 50% copper reduction could be achieved in LB mediums with 1 ppm, 2ppm, 3ppm and 4ppm Copper (Cu²⁺) ion concentrations in 2 days. The LB medium with a 5 ppm Copper (Cu²⁺) ion concentration showed a 50% copper reduction in its day 3 of incubation and its reduction rate is higher than in other solutions. The LB medium with a 6 ppm Cu²⁺ ion concentration was unable to achieve a 50% copper reduction during the experimental time.

Table 2: Fifty percent (50%) Copper (Cu²⁺) ion reduction of in the medium

	Cu ²⁺ 1ppm %	Cu ²⁺ 2ppm %	Cu ²⁺ 3ppm %	Cu ²⁺ 4ppm %	Cu ²⁺ 5ppm %	Cu ²⁺ 6ppm %	Cu ²⁺ 7ppm %	Cu ²⁺ 8ppm %	Control 01 %	Control 02 %
Day 01	25.7	18.0	14.47	12.93	9.84	6.18	4.67	4.19	6.825	NA
Day 02	60.9	44.8	48.37	19.20	14.68	6.20	4.10	2.01	2.45	NA
Day 03	75.2	59.5	63.90	36.70	26.84	14.53	5.63	5.53	5.95	NA
Day 06	90.1	86.6	89.87	68.98	79.96	20.08	3.79	1.66	3.475	NA
Day 08	93.1	91.5	94.17	83.15	95.74	26.88	2.27	5.23	3.7	NA

*NA- Not applicable

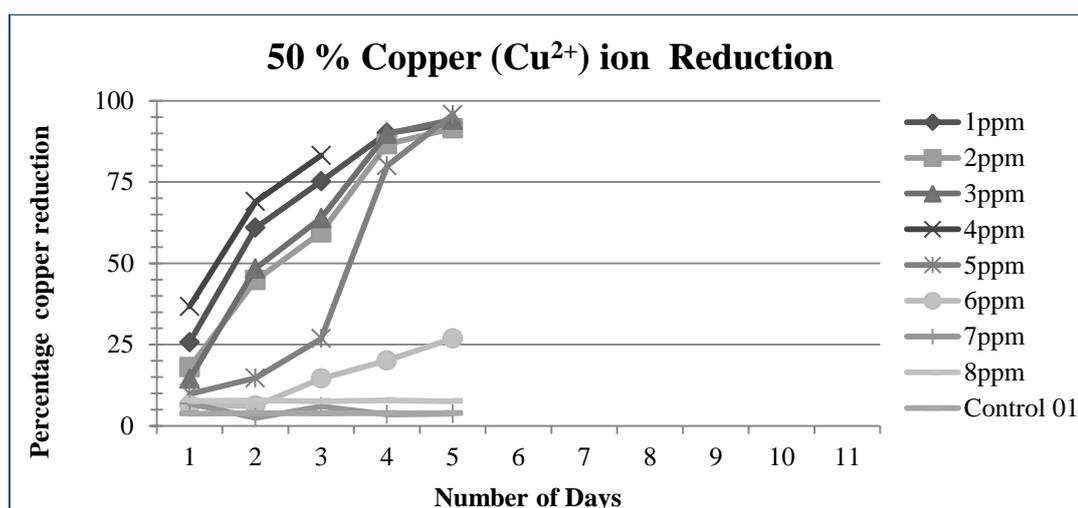


Figure 4: Percentage Cu²⁺ ion decrease in the LB medium with different Cu²⁺ ion concentrations.

The growth of the P strain was completely inhibited at 7 ppm copper concentration. MTC of copper of P the strain was 6ppm. Furthermore the effect of different copper concentrations on bacterial growth was observed by growth curve. The growth curve showed a typical bacterial growth curve with a log phase and a lag phase over the experiment time period. Up to 6 ppm, copper containing culture, the copper concentrations reduce in the medium over the experimental time (8 days). A dramatic reduction in copper ion could be seen up to a 5 ppm copper containing medium. This experiment can be modified by measuring the increase of the copper amount in the dry weight of bacteria.

CONCLUSION

The bacterial P Strain showed a high copper tolerance capability enabling growth in polluted environments with high copper concentrations and has a satisfactory rate of copper biosorption removing copper ions from the contaminated environment enabling bioremediation applications. The probable mechanism for biosorption of the P strain may be metallotionein - mediated complex formation.

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COMMUNICATION AND ADOPTION OF WASTE MANAGEMENT PRACTICES OF URBAN HOUSEHOLDS IN TRINCOMALEE DISTRICT (A SURVEY)

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INTRODUCTION

The Ministry of Environment and Renewable Energy has stated its vision to create “a healthy and pleasant environment sustaining nature for the wellbeing of the people and the economy” (Ministry of Environment and Renewable Energy, 2012). However in achieving this goal Sri Lanka is facing many challenges. Along with the environmental issues such as soil erosion, depletion of coastal resources and loss of bio-diversity, waste-disposal too has become another serious issue (Alagan, 2009). Garbage has become a severe problem in many urban areas in Sri Lanka for a long period of time, adding the country to the list of higher garbage generating countries in Asia. According to the data of the World Bank, the urban municipal solid waste generation in Sri Lanka is 0.8 kg per capita per day. It is estimated that by the year 2025 the urban municipal solid waste generation will increase to 1.0 kg per capita per day (Bandara and Hettiarachchi, 2010). In Sri Lanka, mismanagement of garbage has become the root-cause of environmental pollution and health risks such as dengue fever.

However, the sole responsibility of collection and disposal of waste is on the local authorities. But, inadequate resource availability has made the local authorities to undergo difficulties in waste disposal (Ebert, 2002). Another reason for their failure is the lack of support received from the community. In order to get wider community participation, the immediate neighborhood should be made aware of garbage management. According to Premachandra (2006), one of the common problems in managing municipal solid waste in Sri Lanka is the lack of awareness and education.

In this study the researcher has aimed to showcase the role communication plays in creating awareness and adoption of waste management practices among the people.

Moreover, the specific objectives of this research were:

- to find out information about waste management conveyed to the people and communication channels used for that purpose by different stakeholders ,
- to determine the awareness of people regarding waste management practices,
- to determine the willingness of people towards waste management practices,
- to find out whether people have adopted effective waste management methods and
- to find out the reasons for not adopting waste management practices

METHODOLOGY

The study area of this research is Trincomalee district. Trincomalee is one of the main focus areas of tourism as there are many culturally and naturally attractive places. According to the database of Municipal Solid Waste in Sri Lanka in 2005, prepared by the Ministry of

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Environment and Natural Resources (NSWMS, 2008), the second highest waste generation is reported from the Eastern province, where Trincomalee is the main city.

Out of the 11 DS divisions of Trincomalee district, 3 divisions namely Trincomalee Town, Kinniya and Kanthale were selected for the study, purposely based on the ethnicity of the population. According to statistics, the highest population of Tamils lives in Trincomalee Town and Gravets, the highest Muslim population lives in Kinniya and the highest Sinhalese population lives in Kanthale. From those three DS divisions, 14 GN divisions were selected randomly. The Sample of respondent households was selected using systematic random sampling and the total sample size was 200 households.

The data were collected using a questionnaire and data analysis was done using the Statistical Package for Social Sciences (SPSS). Chi-square tests were used to find out associations between independent and dependent variables, ANOVA and Independent sample t-tests were used to find out the difference between groups, and correlation was calculated to find out the factors that affect adoption of waste management practices.

RESULTS AND DISCUSSION

Communication and waste management

The findings reveal that to receive information, the respondents used around 20 channels including national mass communication channels, regional formal communication channels and informal communication channels. Television was the mostly used communication channel. Moreover, the Public Health Inspector, School Education, Urban/Village councils and the Newspapers were significant communication channels when we consider the number of respondents who used them and their usefulness based on the frequency, clarity, adequacy and message content of those communication channels. However, as far as the overall message content is concerned, only around 30% of information delivered was directly related to waste management practices.

Awareness of waste management

Nearly half of the respondents (57%) were above the average level of awareness of waste separation. Majority of the respondents (75.5%) were above the average level of awareness of recycling. Around 62.5% were above the average level of awareness of composting and 76.5% respondents were above the average awareness level of waste mismanagement. Awareness level of waste separation, recycling and waste mismanagement were significantly different among the ethnic groups, whereas the education level of the household head was significantly associated with the awareness level of waste separation. The awareness level of composting was significantly different between the education levels and the employment statuses of the spouses.

Among the communication channels studied, the newspaper, television, school education and NGOs were effective communication channels in improving the awareness level of waste management.

Adoption of waste management practices

Majority of the participants adopted waste separation (73%) and recycling (85%), whereas the adoption of composting was very low (40%). The adoption level of waste management was significantly low among Tamil ethnic community than the Sinhalese and the Muslim ethnic communities. The reason for this might be the attitude level of the respondents, as the attitude level of Sinhala community is higher than the other two ethnic groups. Moreover, reception of waste collection service is low among Sinhala community than the other two communities. This also can have an impact on the adoption level as the people have no other option to dispose their waste than following the proper waste management practices.

A significant positive correlation was found between the number of children under 19 years of age and the adoption of waste management practices ($r = .202$, $p = .004$) Households with children who were under the age of 19 were more likely to adopt waste management practices. The reason for this might be that the majority of the children under 19 years of age are school children. According to the descriptive data gathered communication channels, most of the message content related to waste management was delivered through school education.

Messages delivered by television, school education, Urban / Village Councils and newspaper disseminated more information on waste management than the other channels. Pearson correlation coefficient test results proved that even though message content provided through school education ($r = .156$, $p = .028$) and television ($r = .137$, $p = .053$) had a significant positive impact on adoption level of waste management, newspapers ($r = .109$, $p = .125$) and NGOs ($r = .096$, $p = .178$) did not have any significant impact on adoption of waste management practices. The reason for this might be that television and school education disseminated information on the harmful effect of waste mismanagement, composting, waste separation, recycling and information of waste management in general than the newspapers and NGOs

Reasons for non-adoption of waste management practices

The mostly mentioned reasons for people not adopting waste separation, recycling and composting were the inefficient waste collection processes of Urban/Village Councils, inadequate time, lack of knowledge, lack of space, absence of the service of local vendors, lack of interest and lack of time.

Additionally, it was found that the awareness level and the receipt of the service of local vendors had a positive impact on the adoption level, whereas receipt of waste collection services from Urban / Village Councils had a negative impact on adoption level.

CONCLUSIONS/RECOMMENDATIONS

Thus, it is strongly recommended that a well-planned program should be implemented to obtain the best use of available communication channels to improve the awareness level of the people and to convince them to adopt waste management practices. Moreover, communication alone will not be able to improve the situation unless supporting services are improved.

The results of the study showed that education plays a major role in promoting waste management among households. In that sense as Hassan (2002) suggests, 'waste education should be made mandatory and be included in the school curricula right from kindergarten to high school levels'.

Moreover, results reveal that illegal dumping, littering waste carelessly at public places and water sources, not separating waste at the source, burning and burying waste are common practices among people which cause environment pollution and destruction of natural beauty. Thus, legal initiative to prevent these occurrences is a necessity. Waste separation at the source of their generation should be strictly exercised as it can prevent many mismanagement processes of waste.

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**MEDIA PORTRAYAL OF SRI LANKAN WOMEN CELEBRITIES IN THE
POLITICAL SPHERE: AN OBSERVATION OF MEDIA CONTENT ABOUT
CELEBRITY WOMEN CANDIDATES IN WESTERN AND SOUTHERN
PROVINCIAL ELECTIONS.**

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INTRODUCTION

The shaping, packaging and presentation of women in politics, especially women celebrities who have been made role models for young people by the mass media, is one area where it is vital to consider not just the messages that are received but the long-term impact of these messages. The media's role during elections, according to the generally accepted view of the people who uphold democratic values, is to inform voters about the competing political parties, their programs, the candidates and their vision and to contribute to the formation of opinion in the electorate. This function further includes the dissemination of formal voter education material provided by the body in charge of election management as well as fair, objective and independent reporting. Is this role fulfilled by the major media outlets in Sri Lanka during elections? We raise this pertinent question looking at the recently concluded provincial council elections in the Western province and the Southern province of Sri Lanka and the media's portrayal of film stars or celebrities. As all of us are aware media is one of the major forces of socialization and its contribution to the role modeling and opinion formation cannot be denied. Mass media shapes our perceptions, expectations and aspirations. Media professionals, as powerful intermediaries especially in politics, supply us with one of the lenses through which we are forced to view the world - a "reality" with which we attempt to understand what surrounds us or what goes around. Fortunately or unfortunately some of these lenses, focused or framed in a particular way, persuade us to evaluate public figures in certain ways and not in others, with the end result that some views remain out of our collective vision. By content analysis and frame analysis of the reports about the celebrities in the broadcast and print media, this research paper aims to showcase both the values that are inherent in the reporting of women celebrities during the recently concluded elections in Sri Lanka and the public expectations which may result from these reports.

LITERATURE REVIEW

There is already a body of academic work which suggests that women politicians across the world are stereotypically always seen as mothers, housewives or sex objects and that none of these roles is viewed as compatible with political leadership (Sapiro 1993). A comparative study of the French and British media between 1981 and 1994 (Freedman, 1997) has found that female politicians in both countries are still portrayed in terms of classic stereotypes of femininity, which is perceived as incompatible with the exercise of political power. The research shows that the presentation of female politicians is intimately linked to an inter-related set of political, social and media representations which casually categorized women politicians according to traditional myths of masculinity and femininity. In Sri Lanka too, there is a huge body of research and publications, especially in the English language on the

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political representation of women. These are inspiring and providing stimulus to much of the activism to increase women's political representation in Sri Lanka without gender biases. In a Chapter titled, "Representation in Politics: Women and Gender in the Sri Lankan Republic", Maithre Wickramasinghe and Chulani Kodikara (2013) ask critically if the state has indeed represented the interests of women as a collective sex/gender, looked at the dominant political representation of women within the state, their exclusions and inclusions and the problems relating to such representation. Furthermore, according to Kodikara (2009), some of the obstacles to women's equal representation are now well documented. These obstacles seem to operate mainly at three fundamental levels:

- at a personal level, where fewer women than men self select themselves for a career in politics due to socio-cultural, economic and psychological barriers,
- at the level of political parties, where women are mostly ignored as candidates for elections, and
- at the level of the electorate, where voters have to vote for candidates.

THEORETICAL FRAME WORK

Media scholars Maxwell McCombs and Donald Shaw (1972) articulate that the "Mass media have the ability to transfer the salience of items on their news agenda to the public agenda". However, they are not implying that print and broadcast journalists make a deliberate attempt to influence the listener, viewer or reader opinion on key issues. And yet, according to them, the general audience look up to media professionals for cues to focus their attention. In McCombs and Shaw's words "we judge as important what the media judge as important". Until recently, till the 1990s, the trend was that the media are not very successful in telling us what to think, but they are stunningly successful in telling us what to think about. In simple words, the media make some issues more salient. Audiences generally pay greater attention to those issues and regard them as more important. By the mid-1990s, McCombs went further and said that the media do more than that. They also try to influence the way people think. The specific process he cited is today known by media scholars as "framing". James Tankard (1991), one of the leading writers of mass communication theory, defines a media frame as "the central organizing idea for news content that supplies a context and suggests what the main issue is through the use of selection, emphasis, exclusion and elaboration.

METHODOLOGY

Using frame analysis and content analysis, this research examines the types of messages that are transmitted by the writers of the articles and presenters of radio and TV to find out whether gender-based stereotypes continue to be reinforced in the media even when reporting of celebrities, especially women who tried to contest for provincial council seats in two major districts in Sri Lanka. In the media's portrayal, are these celebrities viewed as more knowledgeable about politics than the average citizens? Do these celebrities draw attention towards political candidates and salient issues? What do these women celebrities in Sri Lanka represent? What are the problems relating to such representations?

This research uses the term 'sex/gender' to indicate the argument that men and women are both biologically and socially constructed beings within what Sandra Harding conceptualises as a sex/gender system in societies that trigger gender inequality and inequity, patriarchal institutions and the oppression of women. (S. Harding, 2004).

The time period of research is from 30th January, 2014, the date nominations for provincial council elections were opened, to 29th March 2014, the date the elections were held. For the sample of the research, all political broadcasts on TV and radio, and feature articles in the main print media were distilled and analyzed several times to identify the main frame or the central argument.

A celebrity is usually defined as a "famous person". However, in this study it is more specific in its definition to avoid ambiguity. So for this paper the definition of a celebrity is a person who is known as an actor, actress, comedian, singer, musician, talk-show host or athlete. We

look at a convenient sample of how the main print media in English and a selected, popular and private FM station, namely “Neth FM” with its famous “viridu sural” singing of songs, portrayed women celebrities who entered their first political theatre, the provincial council elections, in view of getting selected and making them probable candidates in future parliamentary elections. “Viridu Sural” are songs that come from the ancient times and sung with a hand drum to give a particular message which is very often sarcastic and cynical and often making use of pun in the language. Further, the researcher has analyzed some of the popular feature programs in privately owned TV stations, namely Derana TV, Vade Pitiya (a debate forum on salient issues and current affairs) and “Sirasa TV”.

RESULTS AND DISCUSSION

When one compares the media portrayal of men, in the same newspapers, radio broadcasts and television programs of the political theater, whether celebrities or other professionals, there is a notable polarity in the language used to describe political female celebrities and their male opponents. Several themes emerge in the way women celebrities are portrayed. Among them the following pattern emerges:- a predominance of adjectives which focus on their feminine, caring side,

- a preoccupation with bereavement, grief and their plight as widows or bereaved daughters,
- coming from a political family, following a footsteps of a father/mother,
- a focus on their physical appearances, their clothes and hairstyles,
- attaching importance to their parental and marital status,
- the down-playing, deliberate or otherwise, of their political accomplishments and attributes (in stark contrast to the language used to describe male politicians, where personal status and accomplishments are highlighted) and
- bringing out matters pertaining to their private lives or controversial/sensational statements they had made previously on nudity, female prostitution, etc.

In addition to these, some of the feature articles in the news media and broadcast and TV presentations generally depict female celebrities running for the provincial council elections as weak, dependent, passive, naive, illogical, gentle and un-ambitious.

CONCLUSIONS/RECOMMENDATIONS

In general, while the image of men in politics is portrayed as strong, powerful, intelligent and rational, women are presented as emotional, sympathetic and subservient with a general feminine outlook which is traditionally pleasing to the people. In the long run this type of attitude cultivation has negative consequences, since the mass media are important tools of gender socialization and media texts work as “forms” of pedagogy (Kellner, 1955b). It could be said that media in Sri Lanka have a long way to go in promoting gender equality. The study, at an overall level, is a contribution to the body of knowledge relating to the country’s political and media culture that helps to portray the real character of the established social and political systems at large. It also explains how trends such as women’s involvement in politics will contribute towards a qualitative growth or a radical decline in the democratic way of life in Sri Lanka.

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THE IMPACT OF PERSONALITY ON SOCIAL MEDIA USAGE WITH SPECIAL REFERENCE TO THE UNDERGRADUATES OF THE RUHUNA UNIVERSITY

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INTRODUCTION

Human beings have been living in groups throughout the history in order to satisfy their various requirements. It creates social networks in the world. As a result of technological advancement, Information Technology (IT) has experienced a major breakthrough and led to employ computers at nearly all aspects of daily life. New technology has changed the existing offline relationships among individuals and has created new forms of online social networking. It helps individuals to make connections with people around the world in a virtual setting (Hsu, Ju, Yen, & Chang, 2007). As per Sproull and Faraj (1997) physical location is not relevant, numbers of participants are relatively invisible and logistical and social costs are lower in electronic communities. As per Kemp, (2012) the world internet penetration is 30% and social media penetration is 22%. 7 Out of 10 Internet users are one is a member of at least 1 social network. This indicates that more than 1.5 billion people are using social network sites.

Social behavior of human being can be explained through various factors such as biological, psychological and sociological. This study, attempts to explain how psychological factors, namely personality is conditioning sociological behavior in social media usage. Personality can be identified as the leading factor in understanding why people behave the way they do on the Internet (Amichai-Hamburger ,2002). Correa, Hinsley, & Zuniga, (2010) mentioned that users' personality traits can be the most important factor that impact on social media usage.

Five factor models is one of the well-researched and well-regarded measures of personality structure in recent years (Golbeck, Robles, & Turner, 2011) which including the following factors: extraversion, neuroticism, openness to experience, agreeableness, and conscientiousness (Correa, Hinsley, & Zuniga, 2010). Extraversion is positively related to the number of friends, posting comments, posting self photos, and updating status, but negatively related to playing online games (Wang et al., 2012). Agreeableness is positively correlated with communication on social networking sites (Seidman, 2012). Higher conscientiousness has a higher number of friends and less use of the picture upload (Amichai-Hamburger & Vinitzky, 2010). Neuroticism is positively related to updating one's status and openness to experience is positively related to playing online games (Wang et al., 2012).

When it comes to the Sri Lankan context, there are 1,235,080 users in Sri Lanka, and it's 75 in the ranking of all Facebook statistics by country. Population penetration rate is 5.74% and it is 69.53% when compared to the number of Internet users (Sri Lanka Facebook statistics). 45% of total users are from age group 18-24 followed by 25-34 (33%). There are 65% male accounts and 35% female accounts (Insights into Sri Lankan Facebook pages: MNC and Social Bakers). As per above statistics undergraduates are in the big category. In the Ruhuna University the undergraduates have access to the Internet within their academic time period free of charge.

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It is important to study about personality factors in order to get an accurate picture about the phenomena of social networking sites within the Sri Lankan context. It is expected to achieve the following research objectives relating to the most famous social networking site Facebook considering it as a collection of features (status updates, comments, wall posts, private messages, chat, groups, and applications).

Research Objectives

- To identify the level of Facebook usage (status updates, comments, wall posts, private messages, chat, groups, applications) among undergraduates at the Ruhun University
- To examine the impact of personality factors on the use of specific Facebook features
- To identify the salient personality factor which influences Facebook usage?
- To identify the significant differences in the Facebook usage patterns between gender groups

METHODOLOGY

This study explains the nature of the relationship between personality factors and use of specific Facebook features. Study was conducted in non contrived environment because it deals with students' normal behavior. Population was confined to undergraduates in the Faculty of Management and Finance, University of Ruhuna. Student list of the Faculty of Management and Finance was used as the sample frame and 182 students were selected based on simple random sampling method. Further, this study is a cross sectional study. Researcher used self-administered questionnaire which included closed questions, where respondents had to make their level of agreement such as, Strongly Agree, Agree, No idea, Disagree and Strongly Disagree. Scores of 5, 4, 3, 2, and 1 were assigned respectively for above mentioned categories.

Measurement

"Use of specific Facebook features" (status updates, comments, wall posts, private messages, chat, groups, applications, Facebook friends) was the dependent variable and measured by items about frequency of use. The scale was directly adapted from Smock et al., (2011). Personality is the independent variable and respondents had to rank how much they agreed with these statements on a 5 point Likert-type scale. The scale was developed based on Rammstedt, John, (2007) and Gosling, Rentfrow, William (2003). Personality was measured using big five model and following dimensions were included in the questionnaire. extraversion, agreeableness, conscientiousness, neuroticism and openness to new experience. The data were analyzed mainly by using descriptive statistics, correlation and regression etc.

RESULTS AND DISCUSSION

Analysis of objective one: Means were used to examine the degree of Facebook usage. According to the analysis all mean values indicated that there is a high level of usage.

Analysis of Objective Two: With regard to the status updates neuroticism was the only predictive factor. Comments were predicted by extraversion and agreeableness while agreeableness was the most significant factor. Agreeableness, conscientiousness and neuroticism predict the wall post. Neuroticism was the salient factor. When it comes to the private messages, there were two predictor's agreeableness and conscientiousness while agreeableness was the most significant. Chat was predicted by extraversion, agreeableness and conscientiousness. Agreeableness plays the significant role. There were no any predictors for Facebook groups. Facebook application was only predicted by agreeableness. There were four predictors for number of Facebook friend extraversion, agreeableness, conscientiousness and openness to experience while agreeableness was the salient factor.

Analysis of Objective Three: As per the analysis, agreeableness is the salient factor which influences the Facebook usage.

Analysis of objective four: According to the analysis, there was no significant difference in Facebook usage patterns between gender groups, indicating gender does not affect the Facebook usage patterns. The analysis provides evidence that there is a significant difference in the number of Facebook friends between gender groups, indicating that gender does affect the number Facebook friends.

Discussion

The Big Five Model and SNS use

Findings indicate that extraversion positively relate with number of friends and comments, but negatively relate with chat feature. These findings are also consistent with previous studies that reported significant relationships between extraversion and number of friends (Wang et al., 2012, Amichai-Hamburger & Vinitzky, 2010, Moore & McElroy, 2012). Further we can agree with Amichai-Hamburger & Vinitzky, (2010) suggesting that there were no effect of extraversion on Facebook groups. More over, we can provide evidence to support Moore & McElroy, (2012) mentioning that no relationship exist between extraversion and wall post. But we can't agree with Ryan & Xenos, (2011) on chatting feature because we found a negative relationship between extraversion and chat. Further, our findings do not match with the Ross et. al (2009). These differences may be due to the different measurements used in studies and the different cultural context. Both studies were in the US context which represents individual culture, but Sri Lanka is a collective culture. We found significant positive relationship between agreeableness and subsequent Facebook features comments, message, chat and application. Findings will concur with Seidman, (2012) and conclude that agreeableness relate with communication on SNS. The findings point out that conscientiousness negatively relates to chat and number of friends. Will agree with Moore & McElroy (2012). Our findings does not relate with that of Amichai-Hamburger & Vinitzky, 2010. We found a significant negative relationship between neuroticism and status updates and with wall post. Findings do not concur with Craig Ross *, 2009.

Gender and Facebook usage

It was found that gender affects only for the number of Facebook friends not with the Facebook usage patterns. Findings do not concur with Hargittai, 2007, Giannakos et al., 2012, Glynn et al., 2012. This may be due to the cultural reasons. Normally in Sri Lankan culture girls are not expressive as in the western culture. They are willing to foster relationships with people who are familiar with them. Therefore, they limit their number of friends. Most girls do not accept a new request which is unfamiliar to them. But normally boys display the opposite behavior.

CONCLUSIONS/RECOMMENDATIONS

Contribution of the study and Future research

This study provides a broader framework to measure the impact of personality on social media usage patterns. Sri Lanka is a collective culture and a rapidly developing economy. Current adoption of Facebook among the Sri Lankans is high. As per author knowledge, there are a few studies done in Sri Lankan context in relation to social media. This study creates a background for the social media theory development in Sri Lankan context. Further, social media marketing plays a significant role in contemporary marketing. Personality is a major factor that influences consumer behavior. From this study marketers can get an idea about the insight of consumer personality and the way they use Facebook. It will help them to create a sound social media strategy. Even though SNS is a global phenomenon, it is constrained by local conditions such as culture. Therefore, culture can be included as a moderating variable in this model. Especially individualism and collectivism can be used in future studies.

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ENVIRONMENTAL PHILOSOPHICAL IDEAS IN BUDDHISM: A PHILOSOPHICAL ANALYSIS

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INTRODUCTION

Environmental philosophy is a recently emerged branch of philosophy in the West. This branch studies the relationship between humans and non-humans (animals, plants and inanimate things) and asserts that non-humans have equal rights as human beings do. This new trend of philosophy criticizes the metaphysical stance and the ideological positions of traditional philosophical systems, as well as those of some major religions. Environmental philosophers of the West have not succeeded in proving an anthropocentric ideology in Eastern religions and philosophies (Hindu, Buddhist and Chinese traditions). On the contrary, they consider that the above said traditions constitute proto-environmental ideology. This paper analyses the environmental philosophical ideas embedded in the Buddhist philosophical system. This paper also clarifies the ideological and metaphysical stances that are contained in the “environmental ideas” of Buddhism. The environmental philosophical ideas in the West have originated and developed from the rationalistic and positivistic dimensions of knowledge, but it is believed that Buddhist environmental philosophical ideas have originated and been developed from the mystic and metaphysical dimensions of knowledge. The main aim of this paper is to unearth similar lines of thoughts in the two different realms of knowledge (modern environmental philosophical ideas and Buddhist environmental ideas) and to clarify the back grounds to the claims of Buddhism in association with the Western environmental philosophical background.

METHODOLOGY

This paper includes the main methods of philosophy, such as the critical evaluation of beliefs and the clarification of concepts. Apart from this, analytic, synthetic, comparative and holistic methods have been used in this paper. For appropriate references, the original texts of Buddhism have been used.

DISCUSSION

Many ethical ideas of Buddhism correspond with modern environmental ideas and are based on a deep philosophical foundation. Its ethics consists of positivistic, metaphysical and non-anthropocentric ideas. The precept of *ahimsa* takes a prominent place in Buddhist ethics. It is obvious that the scope of *ahimsa* in Buddhist ethics is more than that of modern environmental ethical ideas. The eight-fold path is considered important in the teaching of Buddhism, and the fourth principle of this eight-fold path is known as ‘right doing’ (*samayakkaramanta*). It includes the *pancasila* (the five virtues). The first virtue of the *pancasila* is *ahimsa*, which is interpreted as ‘not to kill but to practice harmlessness and compassion towards all’. It is important to note that one cannot restrict the precept to mobile beings in Buddhism, and this precept is extended to immobile beings as well. These types of thought are nowadays insisted on in the realms of environmental philosophy and ecology. The fifth principle of the eight-fold path is known as ‘right livelihood’ (*samyagajiva*), in which the means of livelihood are prescribed. One can find more *ahimsa* in this precept. Accordingly, one’s profession should not deal with (a) arms (b) living beings (c) flesh and (d) poison. Thus, an *ahimsa*-based society is proposed by the Buddha. Within the purview of Buddhist ethics,

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plants and seeds are also included, and this idea reflects modern environmental philosophical ideas:

“He is one who abstains from injury to seed life and plant...” (Wood ward, F.L. 1933 : v.205)

Realizing the life potentiality of plants and seeds is considered to be a great spiritual achievement of Buddhism in the point of view of environment philosophy. Buddhism equates *ahimsa* with righteousness (*dharma*) since *ahimsa* equates with righteousness, we can assume that the protection of other living beings and the environment are essential ingredients of the Buddhist ethics. The following words prove this position:

“Whatever monk should knowingly make use of water that contains living things; there is an offence of expiation.” (Horner, I.B. 1962: IV.124-125).

“He who carries out his purpose by violence is not therein righteous (established in the law). He is wise who decides both advantage and disadvantage He who guides other by a procedure that is non-violent and equitable, he is said to be guardian of the law, wise and righteous.” (Narada 1978: 256,257)

One can find that the precept of *ahimsa* is extended to seeds, fruits and plants in Buddhism. This position of Buddhism would lead us to observe some ethical consideration in the consumption of our food, and this is an important element of environmental ethics as well as of sustainable development. The following words depict this condition as:

“Monks, mangoes should not be made use of. Whoever should make use of them, there is offence of wrong doing. Accept them, monks, make use of them. I allow you, monks, to make use of fruit that in five ways is allowable for recluses: If it is damaged by fire, damaged by knife, damaged by (one’s) nail, if it is seedless, and the fifth is if the seeds are discharged.” (Horner, I. B 1952 : V. 109)

Nowadays, we have enough awareness and justification on animal rights and animal protection, and for this purpose, many organizations are functioning around world. We all know animals are a part and parcel of our environment and as the highest living beings (humans), that we should protect them as much as possible. By various methods, suffering is caused by human beings to animal beings. This idea is highlighted by the Buddha in the following words:

“Monks, you should not catch hold of cows by their horns, nor should you catch hold of them by their ears, nor should you hold of them by their dewlaps, nor should catch hold of them by their tails, nor should mount on their backs. Whoever should (so) mount, there is an offence of wrong doing. Nor should you touch their privy parts with lustful thoughts. Whoever should (so) touch them, there is a grave offence. Nor should you kill young calves. Whoever should kill them should be dealt with according to the rule.”

Now at that time, the group of six monks went in a vehicle and there was a bull in the middle yoked with cows and there was a cow in the middle yoked with bulls. “...Monks should not go in a vehicle. Whoever should (so) go, there is an offence of wrong doing.” (Ibid: V.191.)

Nowadays, protecting trees has become a significant action in the realms of environmental ethics as well as of the sustainable development programmes of various governments and organizations. This idea is initiated by the Buddha in the following words:

“... Doing injury to trees and shrubs is no offence in the eyes of the world, but it is wrong in the religion . The habit of sporting in the water is of no offence to a layman, but it is wrong in the religion.” (Rhys Davids 1965: 266).

COMPASSION AND THE ENVIRONMENT

In Buddhism, it is believed that the Buddha was born for the benefit of living beings in this world. This idea is proved by the following words of an Indian philosopher, Rathakrishnan :

“In the Buddha's scheme of ethics, the spirit of love is more important than good works. All good works whatever are not worth one -sixteenth part of love which sets free the heart. Love which sets free the heart comprises them. It shines, gives light and radiance. ‘As a mother, at the risk of her life, watches over her only child, so let everyone cultivate a boundless love towards all beings.’ Respect for animal life is an integral part of morality. A good Buddhist does not kill animals for pleasure or eat flesh. They are his humble brethren and not lower creatures over which he has dominion by divine right. Serenity of spirit and love for all sentient creatures are enjoined by the Buddha. He does not speak of sin, but only of ignorance and foolishness which could be cured by enlightenment and sympathy.” (Rathakrishnan 1984: 22-23)

DETACHMENT AND ENVIRONMENTAL ETHICS

Detachment in worldly things is always stressed in Buddhism and is considered to be an important characteristic to be developed by ascetics as well as laymen of Buddhism. This characteristic of Buddhism indirectly works towards environmental protection and sustainable development. This attitude of detachment would lead one to lower consumption and minimum usage of things in this world. This attitude prevents one from accumulating much wealth and motivates one to lead a simple life. Thus, the quality of the detachment leads us to sustainable development. The *Dhammapada* expresses this position as follows:

“He who, for his own sake or for the sake of another, does not wish for a son or wealth or a kingdom, if he does not wish for his own prosperity by unfair means he certainly is virtuous, wise, and religious.” (Narada 1978: 84)

NON-ANTHROPOCENTRISM AND BUDDHIST ETHICS

The non-anthropocentric element stressed in modern environmental philosophy is questionable in the purview of Buddhist ethics. Human beings and a male bias are magnified in many dimensions of Buddhism. It is for the achievement of Nirvana of human beings that the ethical precepts are observed by adherents, and not for the sake of the welfare of animate and inanimate entities of the world. This is considered to be a huge drawback in Buddhist ethics from the point of view of Western environmental philosophy. The anthropocentric ideology of Buddhism is expressed in Buddhist ethics, which are based on a mystic and metaphysical back ground. In contrast, Western environmental philosophy is based on Positivism blended with Utilitarianism and Altruism.

CONCLUSIONS AND RECOMMENDATIONS

The Buddhist ethical doctrine and its concepts of *ahimsa*, compassion and detachment can play a vital role in environmental ethics. Actually, it is not an exaggeration to say that the scope of Buddhist ethics is larger than that of environmental ethics. We all know that Buddhist philosophy and religion are deeply rooted in the major parts of Asia. Buddhism is not an asset to a particular community in the world, but is common to all humanity. Thus, thinking about Buddhist ethical ideas and following the Buddhist doctrine would automatically create an environmental practitioner, and thinking in this direction would definitely lead us towards sustainable development. However, the ideology of Buddhist ethics hardly satisfies the paradigms of modern Western environmental philosophy such as Positivism, Utilitarianism and Altruism.

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STRATEGIC COMMUNICATION FOR MICROFINANCE OPERATIONS IN GEMIDIRIYA: A CASE STUDY BASED ON HATHELLEGODA GS DIVISION IN RATHNAPURA DISTRICT

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INTRODUCTION

The Gemidiriya programme is one of the major community development programmes in Sri Lanka that functions as a two-phase project, which was implemented under the Ministry of Economic Development. Phase One was initiated as a four-year programme under the name of *Gemidiriya* and has already been completed. The aim of this phase was to strengthen the rural communities in the Uva and Southern provinces (Gemidiriya, 2008). In this particular programme, microfinance operations have been instituted as a main poverty reduction strategy of the project for the purpose of minimizing poverty, which has been a major concern in achieving holistic development in Sri Lanka.

In the context of community development programmes, different types of communication forms and methods of the development plan, implemented in the different stages of the respective development projects, are fundamental to achieve specific development goals. This is because the application of appropriate development methods and communication strategies has directly influenced the success or failure of development programs (Okunna, 1992). In the context of community development programmes in Sri Lanka, the role of communication processes have received scant attention in the evaluation of the application of communication initiatives used in development projects. Even at present, measuring the result of communication is hardly present in the strategies and policies of most development projects. Therefore, it is important to investigate the success or failure of the Gemidiriya project by evaluating the strategic communication processes used in rural development programmes.

The objective of this study is to examine the impact of strategic communication methods used in terms of operating the microfinance operations at organizational level in the *Gemidiriya* program, which has evolved under three stages that are namely the *introductory stage*, *implementation stage* and *after completion of the project stage*. Further objectives of the study are to examine the effectiveness of the communication processes on attitudinal changes in microfinance activities and to assess the appropriateness of communication methods and strategies that are used in the different stages of the *Gemidiriya* programme. This study was conducted in the *Gemidiriya* village organization in Hattellegoda GS division in the Rathnapura district.

METHODOLOGY

This study is based on case studies and face-to-face interviews as qualitative methods of data collection. Six case studies were carried out with two men and four women who are in decision-making positions in the Hattellegoda Microfinance organization. Therefore, the accuracy of data is at its optimum level as it enables an understanding of the detailed information of the communication processes and their impacts on microfinance operations. Ten authorized bodies attached to the *Gemidiriya* programme, such as the *Gemidiriya* programme and its field officers and the coordinators in the communications division, were interviewed to obtain information on how communication was useful in the setting up of the

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microfinance programme and its progress in this area. Moreover, observation was used to understand the behavioral changes of the target community at organizational level.

THEORETICAL BACKGROUND

The Community Driven Development approach (CDD) has become the emerging model in the world for rural community development programs (Mozammel & Schechter, 2008). This is because the previously used top down and bottom up traditional approaches have been unsuccessful in achieving the expected outcomes of community development efforts (Asian Development Bank, 2004). Moreover, in the best practices of the CDD approach, strategic communication has become a vital part of achieving project success (IFAD, 2004). This strategic intervention improves the main expectations of educating, building relationships, increasing social mobility and building capacity, and changing effective behavior in community operations. Therefore, the *Gamidiriya* community development programme had adopted the CDD model for project operations and strategic communication, which have been incorporated into the development plan to implement the best practices of CDD. In this study, the communication strategic intervention of the CDD model has been taken into consideration to analyse the communication impact on microfinance operations.

FINDINGS AND DISCUSSION

The *Gemidiriya* communication division has formed communication initiatives, combined with different kinds of communication methods and forms, in order to strengthen the communication process that is necessary to set up a strong microfinance system for all three stages of the project. These have been presented below in the three different stages, which are known as the introductory stage, project implantation stage and the after completion of the project stage.

1st Stage: Project Introductory Period - At this stage, the Grama Niladhari and the *Gemidiriya* field officers, who were well-trained for communication for the above purpose, were appointed as the key figures to facilitate the *Gremidiriya* introductory information stage. All essential information was conveyed through workshops and consultations by interpersonal oral communication. Promotional material, such as leaflets and banners, were produced in all three media and were distributed to promote the basic idea of the *Gemidiriya* programme at the introductory stage.

All communication initiatives used at the introductory stage were mostly implemented by Grama Niladhari and *Gemidiriya* field officers. This fact was proved by all case studies and it further emphasized that information given by the Grama Niladharis were trustworthy and reliable. Moreover, it helped to generate a positive impression of the *Gemidiriya* programme among people. *Gemidiriya* officers were used as resourceful figures to give all the necessary programme information, which included the programme in detail and its benefits. This information has helped people in the community immensely in order to get a basic understanding of the project and to finally get project approval. In fact, promotional material, such as leaflets and banners that were produced in all three media, have not made a favorable impact in promoting the basic idea behind the *Gemidiriya* programme. However, intrapersonal, oral communication has been a very effective way of convincing *Gemidiriya* members of the development message.

2nd Stage: Project Implementation Period - Training workshops, individual and group consultations and workshops organized by field officers were the main communication strategies used at this stage. Even though information on the microfinance community operations were produced in all three media, ICT was the main communication strategy used to enhance microfinance operations.

Communication has mainly taken place between *Gemidiriya* facilitators and the people in the community and, during this period, *Gemidiriya* field officers have played a responsible role in training people to conduct microfinance activities at individual and organizational level. Their consultations and trainings have had more of an impact and have mostly used interpersonal oral communication as a convenient method to familiarizing the target community with microfinance operations. Training in microfinance operations has become a more difficult process for men than for women as they were reluctant to change, while a majority of the women did not have any experience and lacked confidence in handling financial activities. This was because the women had mainly been involved only with household activities before the project. Therefore, training sessions, consultations and workshops were organized incorporating communication strategies more. As a part of this strategy, people were trained on simple financial terms, without using financial jargon, and different colors were used to handle accounts. All the case studies emphasized that these trainings had a good impact and made it easy to get familiarized with microfinance operations. In-depth interviews, which were used as a data collection tool, revealed that the *Gemidiriya* officers continuously put effort into giving instructions till all the community members were able to finish their final accounts.

Individual consultation and group training sessions were regularly organized to operate small groups in the microfinance system and all members were given clear instructions to form small groups with neighbours. Apart from that, unplanned regular communication among community members has had a considerable impact in this study, which proved that an informal form of communication has helped to enhance community operations.

The *Gemidiriya* microfinance manual has been introduced as a microfinance operation guide, and participants were instructed to use it as a formal written source to carry out microfinance activities and to resolve microfinance-related issues. This manual includes all project information and procedures laid out in different colours, and uses charts and creative graphics. Furthermore, this manual has been revised and amplified several times to avoid the complications of microfinance-related issues according to community requirements. All case studies proved that this manual was most useful to understand microfinance procedures clearly.

ICT was introduced as a main communication strategy and this facility was provided through the *Nanasala* centers to conduct *Gemidiriya* operations. ICT was utilised to maintain administrative operations, to upload project details on the *Gemidiriya* website and to directly contact the *Gemidiriya* finance director on Skype to obtain advice whenever a complicated microfinance-related issue arose. It indicated the existence of support to maintain transparency in project operations.

3rd Stage: After the Completion of the Project - Communication had not been planned in an advanced manner. Although without *Gemidiriya* facilitators, the implemented initiatives of the implementation stage were continued. Committee members and all *Gemidiriya* members were encouraged to circulate information.

All members in the community finally became familiarized with microfinance system as a result of proper information and training given at the project implementation stage. Therefore, microfinance activities have become a normal routine of the community by the end of the project and all requirements of the microfinance operations are fulfilled by community members.

Even though the development providers moved away from the project at the end, community members are confident in conducting microfinance operations independently.

Moreover, small group discussions and committee members are the main sources of information and they are mostly involved in resolving microfinance-related issues.

The microfinance community manuals are used up to now as a written guide by the community, and ICT is still used to maintain administrative functions in the microfinance operations. ICT and community manuals are still being using as a communication strategy even after the completion of the project. When all the communication initiatives are taken into account, all case studies prove that unplanned communication (informal regular oral communication) among community members are comprise of the majority of functions, and it also strengthens microfinance operations more than planned communication strategies at the end of the project.

General Findings

This microfinance organization received one million bonus prices considering the evaluation criteria of maintaining the organization well for two years with transparency, active participation, equality, efficiency, sustainability, and an ability to continue the organization independently.

CONCLUSIONS

Communication is an integral part of the *Gemidiriya* microfinance operations and is composed of various communication methods and strategies that are functional for communication to be effective at different stages. Moreover, communication played a vital supportive role in strengthening microfinance operations to ensure it was a community-driven mechanism conducted through educating, networking, promoting active participation and building social mobility.

The *Gemidiriya* field officers, as well-trained service providers, played a significant role in training community members in microfinance activities. Their support, especially in relation to the project implementation stage, was required due to many reasons. Especially as people in the community were reluctant to change, it was fundamentally important to provide direction in changing attitudes positively and in building confidence in microfinance operations. Moreover, they helped to conduct self-help processes and to uphold the mobility of microfinance activities at the end of the project without interventions from external institutions or authorities.

Apart from the planned strategic communication, unplanned informal regular communication among *Gemidiriya* members in the community has not only strengthened the communication process, but has also enhanced internal communication capacities. Moreover, it has also helped to network the community. This unplanned communication strategy also supported to make microfinance community operations much stronger. Incorporating appropriate communication strategies have finally become more effective tool in understanding microfinance operations, at both individual and organizational level. This strategic communication is highly required at the introductory and the project implementation stages.

ICT has been introduced as one of the main communication strategies of the project and it has played a supportive role in maintaining the administrative functions of the community operations and to maintain project transparency to access project information.

The traditional interpersonal oral communication mode had more of an impact and was a most convenient mode, at the community level, to deliver relevant development messages effectively in order to increase the productivity of microfinance operations.

RECOMMENDATIONS

A strategic communication plan must be incorporated as an integral part of community development programs and communication impact assessment is needed to be integrated into the project evaluation process to ensure that the used communication strategies and methods are appropriate and effective enough to achieve the desired outcome of the project and to identify communication gaps at the different stages.

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INFLATION, MONEY AND ECONOMIC GROWTH: SPECIAL REFERENCE TO POSTINDEPENDENT SRI LANKA

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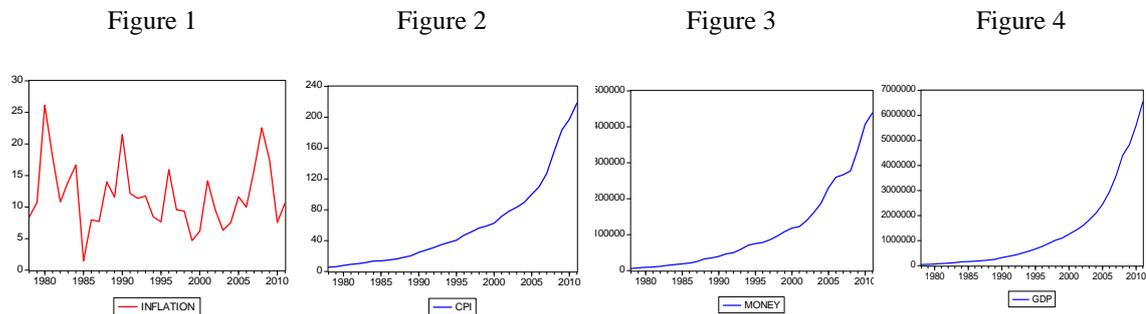
INTRODUCTION

This paper discusses money's role as a determinant of inflation and the economic growth in Sri Lanka. Inflation rate has been one of the most deliberated issues together with theory and practice. In times of global economic integration, countries are progressively influenced by movements in their inflation rates according to the money supply and the real output of their economies. One of the main characteristics of the global economic system is that the dynamics of the inflation rates which is often pervasive. There is a noticeable indicator to measure these fluctuations: the Consumer Price Index (CPI). Here, it is considered the relationship there is between monetary aggregates and inflation, or whether it is driven by economic growth and whether there is any substantial reason for modifying the current convention of policy analysis. The study proceeds by considering the range of ideas known as the "Quantity Theory of Money (QTM)." The QTM is used to explain the long-run determinants of the price level and the inflation rate. It is common to all economies that the overall price level rises, the value of money falls. The money supply is a policy variable that is controlled by the Central Banks through instruments such as open-market operations, that directly controls the quantity of money supplied. The quantity theory concentrates on the forecast that there will be a long-run proportional response of the price level to an exogenous boost in the nominal money stock. The relationship between inflation and money growth eventually is based on the demand for money and the supply of money. The rapidly growing literature on money in relation to economic growth displays a considerable complexity of approaches by different writers. Quantity of money is a causal factor in economic growth. An competent expansion in the money supply can be expected to stimulate a regular and orderly boost in the economy. Changes in quantity of money (MV) are thought of as being sufficiently powerful to determine economic expansion or contraction.

The quantity theory apparent a *ceteris paribus* solitary relationship between inflation, money supply and economic growth. Impersonations of a New Keynesian model nominate that we should expect this relationship to be apparent in time series data, with no heavy averaging required, but with grant needed for the aspect transpose in the relationship between monetary growth rates and inflation. In the QTM, $MV = PY$, where M, Y, and P respectively denote measures of the nominal money supply, real transactions or physical output per period, and the price level, with V then being the congenial monetary "velocity." That well enough distinct motives are committed to the QTM by several authors can be seen by consulting the writings of Hume, Wicksell, Fisher, Keynes, Friedman, Patinkin, Samuelson, Niehans and Lucas. In fact, the subsequent writers have had in ideologies of fiat (paper) money. The QTM is based on the hypotheses: the source of inflation is fundamentally derived from the growth rate of the money supply, the supply of money is exogenous, the demand for money, as reflected in its velocity, is a stable function of nominal income, interest rates, and so forth, the mechanism for injecting money into the economy is not that important in the long run and the real interest rate is determined by non-monetary factors. The idea that persisting variance in the price level and output growth are adjoined with changes in the money supply is one of the earliest and most assured theories in the discipline of economics.

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Figure 1 shows the inflation dynamics of Sri Lanka over the study period. The Consumer Price Index or CPI measures changes in the prices paid by consumers for a basket of goods and services. And the inflation is derived by the CPI. This index records a continuous increment all over the study period (Figure2). Figure 3 indicates the money supply. In this study (M1) money supply is employed and it is a measure of money supply that includes cash and checking deposits. It also shows an upward trend over the time.



The Gross Domestic Product (GDP) in Sri Lanka expanded 8.20 percent in the fourth quarter of 2013 over the previous quarter. GDP Growth Rate in Sri Lanka averaged 6.51 Percent from 2003 until 2013, reaching an all time high of 8.60 Percent in the fourth quarter of 2010 and a record low of 1.50 Percent in the first quarter of 2009. While the historical trend shows an upward movement (Figure 4).

OBJECTIVES

The main objective of this paper is to provide a comprehensive account of the methodological framework to calculate impact of money supply and the GDP on inflation. In addition to that this study strived to analyze the time series properties of the variables used in this study, to understand the behavior of the Aggregate Demand and Supply variables in Sri Lanka, to analyze the short run and long run effect of money supply and GDP on inflation rate and to suggest some policy implications.

HYPOTHESES

This study establishes two hypotheses. The first one will measure the impact of money supply on inflation.

- H_0 : Money Supply does not positively relate with inflation.
 H_1 : Money Supply influence inflation positively.

While the second, the healthiest one measures the impact of economic output on inflation.

- H_0 : GDP does not positively relate with inflation.
 H_1 : GDP influence inflation positively.

METHODOLOGY

This section describes the methodology behind the inflation, money supply and GDP of Sri Lanka. Taking economic theory and data constraints into account, it presents the options available for construction of dynamic Keynesian model of macroeconomic equilibrium concept to Sri Lanka. In particular, the study period of this study is 1977-2012. 35 annual observations are employed. Data come from the Central Bank of Sri Lanka (CBSL) Annual Reports, IMF Publications and *Econstat* data of the World Bank. The basic variables in this study are Consumer Price Index, M1 Money Supply, GDP, Consumption Expenditure, Investment, Government Expenditure, Exports and Imports. These are used to derive all the other concepts related to the study. As the first inflation rate has been calculated. The

following formula is used.

$$\text{Inflation}_i = \frac{CPI_i - CPI_{i-1}}{CPI_{i-1}} \quad (1.1.)$$

Money supply has a positive long run relationship with price level where the GDP remains constant;

$$(1.2)$$

$$M\bar{V} = P\bar{Y}$$

In reality the GDP will not be a constant and it depends on Consumption, Investment, Government Expenditure, Imports and Exports.

$$Y = C + I + G + (X - M) \quad (1.3)$$

Therefore, the Price level will be a function of Money Supply, Consumption, Investment, Government Expenditure, Exports and Imports.

$$P = f(MS, C, I, G, X, M) \quad (1.4)$$

All variables are transformed to natural logarithm. A log-linear specification of the statistical model can be stated as follows:

The long run relationship can be stated by;

$$\log P = \beta_0 + \beta_1 \log MS + \beta_2 \log Y + \varepsilon_t \quad (1.5)$$

While the short run relationship is tested by;

$$\log \Delta P = C_0 + C_1 \Delta \log MS + C_2 \Delta \log Y + \varepsilon_t \quad (1.6)$$

Where log P implies the Price level, log Ms denotes the money supply and log Y denotes the national output respectively.

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 Phillip Perron (PP) test. Then Engle-Granger co-integration test is employed to investigate the long run relationship. To study the short run dynamics of inflation, the Error Correction Model is employed. The Granger-causality test is used to examine the direction of causal relationship between these variables. Impulse Response Function is used to measure the inflation direction due to the external shocks.

RESULTS AND DISCUSSION

Long Run Relationship

After controlling for other structural and policy variables, the results lend support to the hypothesis that the inflation was a key fundamental behind the post-1970s economy in Sri Lanka. The impact of money supply and national output on inflation in the long run and short run has been examined. The results of unit root test (ADF) indicated that all variables are non-stationary at level and they are stationary at first differences. Based on these results, The cointegration analysis is employed to find out the long run relationship. The residual estimated from cointegration regression equation is tested for stationarity. According to ADF test results (ADF stat=-5.208(p=0.0002)) the estimated residual is stationary. This indicates that LMS, LY, are cointegrated. Estimated equation is given below:

$$\log P = -5.99 + 0.157 \log MS + 0.67 \log Y + \varepsilon_t \quad (1.7)$$

Table 1: Cointegration Test Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LMS	0.157338	0.069610	0.823714	0.0416
LY	0.676197	0.059673	11.33171	0.0000
C	-5.999392	0.067360	-89.06459	0.0000

According to the results of this equation, national income has significant impact on inflation (67%) while the money supply has relatively less impact (15%) on inflation in the long run. Therefore the inflation occurred in the short run will be a good sign of economic growth of Sri Lanka.

Short Run Relationship

To identify the short run dynamics the Error Correction Method has been used and the generated results are included in the following table.

$$\log \Delta P = 0.011 + 0.046 \Delta \log MS + 0.69 \Delta \log Y + \varepsilon_t \quad (1.8)$$

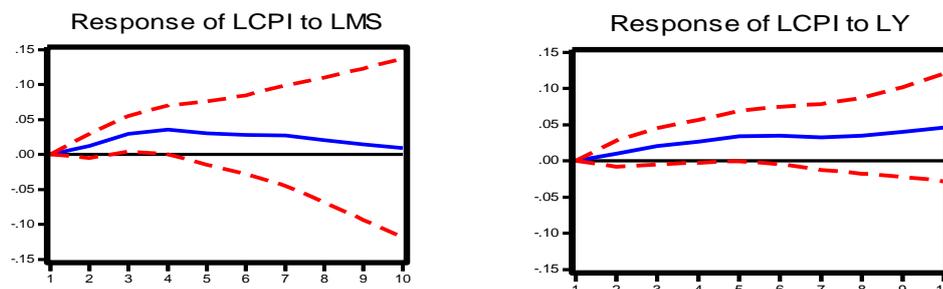
Table 2: Error Correction Test Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LMS)	0.046716	0.094848	-0.492538	0.6259
D(LY)	0.691265	0.123907	5.578890	0.0000
C	0.011591	0.023091	0.501977	0.6193

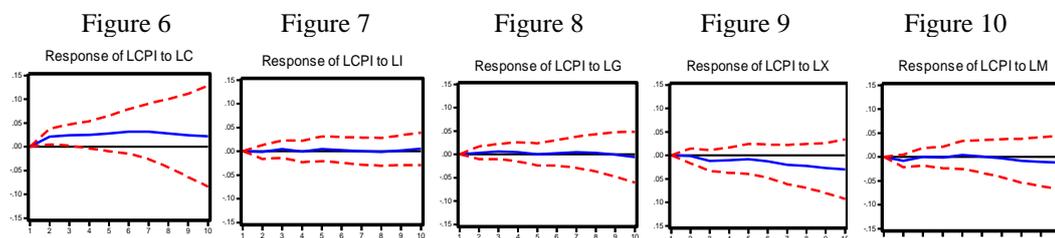
Short run dynamics suggests that the money supply is insignificant. The reason for this insignificance is that in the short run money velocity remains unchanged. But the national output increment leads for an inflationary effect.

Inflation Response to the External Shocks

The model is solved and the impulse responses are computed. The estimated results show the following responses. Figure 5 plots the responses to a unit monetary policy shock of money growth, inflation, nominal interest rates, and nominal income growth.



The monetary policy shock lowers the nominal interest rate and leads to an immediate rise in money growth. Figure 6 plots responses to a (positive) potential output shock. This shock increases inflation but with a less percentage than money supply does. Figure 6 shows the response of inflation due to a shock in consumption level of the economy. The shock will gradually increase and following 6 time lags it will worsen. Figure 8, 9 and 10 show the inflation behavior due to external shocks to the government expenditure, exports and imports respectively.



Granger Causality test confirms that the money supply and national output cause inflation.

Table 3: Granger Causality Test Results

Null Hypothesis:	Obs	F-Statistic	Probability
LMS does not Granger Cause LCPI	32	1.76627	0.19016
LY does not Granger Cause LCPI	32	2.41834	0.10811

CONCLUSIONS/ RECOMMENDATIONS

The paper has considered the relationship between monetary aggregates, GDP and inflation, and whether there is any substantial reason for modifying the current mainstream mode of policy analysis, which frequently does not consider monetary aggregates at all. The quantity theory, as defined, centers on the prediction that there will be a long-run proportionate reaction of the price level to an exogenous increase in the nominal money stock. Engel Granger test attested the long run positive relationship of inflation with money supply and national output growth in Sri Lanka. Error correction method verified that there is no such an influence in monetary aggregates to the inflation in the short run. In Sri Lankan situation, since the growth of output (GDP) has a greater positive impact on inflation compared to growth in monetary aggregates in the long run. Therefore it is not that possible to ignore the inflationary impact of money supply increments since it contributes for 10% inflationary impact. In order to control the inflation the government has to use some other methods. The way governments used to control inflation should be by the raising and lowering of central bank interest rates. This has the effect of raising or lowering the relative value of the national currency. It also affects the money available for investment and the running costs of most businesses. So a reduction of interest rates would reduce the value of the currency, make exports cheaper, imports dearer and make businesses more profitable. And also the money supply should be adjusted proportionate to the output growth.

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MOTIVES FOR CONSUMING LUXURIES AMONG TAMIL COMMUNITY IN VAVUNIYA DISTRICT

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INTRODUCTION

The phenomenon of “luxury consumption” has become increasingly evident in modern society. People may purchase certain expensive “luxury goods” according to what they mean to them and to members of their social reference groups. Therefore, both academics and marketers accept that the demand for luxurious goods is mounting rapidly all over the world. In early stages, luxury consumption was more or less limited to lavish societies, as wealthy individuals often consume highly luxurious goods and services in order to publicize their wealth, thereby achieving greater social status. Yet, the tendency to buy expensive and noticeable goods is now becoming a common pattern of consumer in most of the societies and it makes up an overwhelming part of the consumption where it does exist.

The term luxury(or conspicuous) consumption was coined by the American economist and sociologist, Thorstein Veblen in his most famous work *The Theory of the Leisure Class* in 1899 where he defines it as the buying of unnecessary and expensive products and services as a way to show off wealth. In his words, “*in order to gain and hold the esteem of men, it is not sufficient merely to possess wealth or power. The wealth or power must be put in evidence, for esteem is only rewarded on evidence (p.3).*” Veblen suggested that one possible way to provide evidence of wealth was through consumption of ‘luxurious and visible goods’.

A good is considered luxurious when its characteristics and the amount an individual consumes of the good can be publicly observed (Amaldoss & Jain, 2005; Bergman, 2010; Danziger, 2005; Sundie *et al*, 2010). An evolutionary perspective suggests that manifest of wealth may serve as a communication strategy designed to gain reproductive rewards. This happens because of an individual’s utility is directly increased by paying a higher price (Creedy & Slotte, 1991). The higher the cost of display, the more likely is the consumer to signal by purchasing high-price conspicuous goods (Charoenrook & Thakor, 2008). Therefore, consumers’ preferences for the enhanced social status are usually conferred by the visible and luxurious ownership of certain goods.

This paper explores the motives for luxurious consumption among the Tamil community living in the Vavuniya district of Sri Lanka. In particular, it addresses two most important questions; How Tamil consumers make the conspicuous choice in a modern market flooded with luxury products? What are the motives which affect their luxurious consumer behaviour?

METHODOLOGY

The initial stages of this research consisted of a review of the literature pertaining to the motives for consumption of luxuries. Based on these findings, a questionnaire was developed to gather the views of respondents. Research tool consisted of two sections; section 1 and 2. Section 1 of the questionnaire was designed to measure consumer motivation for the consumption of luxury products. The scale development paradigm recommended by Churchill (1979) was used as the basis for developing a measure of consumer motivation for consumption of luxury products. Section 2 of the survey instrument measured a number of demographic and behavioural variables.

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With respect to the second research question, the model of motivation for consuming luxurious goods developed by Vigneron and Johnson (1999) was empirically tested with little modification. This model proposed that five forms of motivation would exist; status, uniqueness, conformity, hedonic, and quality. In the present study, only four motives were used. The quality motive was not taken as separate, but coupled with the hedonic motives.

The sampling frame for this research was the consumers living in Vavuniya district secretariat division. The main reason for selecting Vavuniya District is, among others, it is a multi-ethnic district with an estimated population of 182,957 (as at 31.12.2007). The total population comprises 82.4% of Sri Lankan Tamils, 10.0% of Sinhalese, 6.9% of Sri Lankan Moors, and 0.7% Indian Tamils. Until 2008, some parts of the Vavuniya District were under the pressure of civil war.

A total of 350 responses were obtained by way of a field survey, and a total of 344 (n=344) usable responses were obtained. This response rate was clearly satisfactory. Respondents were asked to assign rank "5" to denote the most relevant statement and rank "1" to denote the least relevant statement. Along with other exploratory data analysis methods, the SPSS (version 17) data analysis software was utilized to facilitate an objective assessment of data gathered.

RESULTS AND DISCUSSION

The sample of this study was highly dominated by the male respondents (54.9%; n=189) and the majority of them belonged to 30-39 years age group. The vast majority of respondents, who responded, identified themselves as "*Tamil-Hindus*" (91%; n=313). Only 9 percent identified themselves as "*Tamil-Catholic*" (Table 01). Respondents' average family income was nearly Rs. 28,600 per month. Yet results reveal that the average income for most of the respondents skewed towards the middle income brackets.

Table 01: Demographic Characteristics of Respondents

Sex	%	Age group	%	Education	%
Male	54.9	18-29 yrs.	27.9	Up to grade 8	29.7
Female	45.1	30-39 yrs.	34.6	G.C.E. (O/L)	39.2
		40-49 yrs.	25.6	G.C.E. (A/L)	26.7
		Over 50	11.9	Graduates	3.2
				Diploma Holders	1.2

The conspicuous motives towards luxury products were measured in four aspects: uniqueness motive, status motive, hedonic motive, and conformist motive. And a summated scale was created for each of the four motives identified in this study (Allison, 2008). The mean scores on the four motives were calculated and are reported in Table 02, along with t-tests based on the whole sample.

The results reported in Table 02 indicate that all four motives are significant motivators of the consumption of luxurious products for these consumers ($p < 0.001$). Respondents revealed that they would be more attracted to purchase luxurious products ($\bar{x} = 4.03$, $SD = .069$) by the hedonic motive. Therefore, hedonic-seeking emerged as the most important motivation for the consumption of luxurious products for Tamil community in Vavuniya district.

Table 02: Means, T-Test and ANOVA for Conspicuous Consumption Motives

Sample	Conspicuous Motives			
	Uniqueness Motive	Status Motive	Hedonic Motive	Conformist Motive

Tamil	Mean	3.83	3.45	4.03	3.12
people in	Std. Deviation	.781	.748	.069	.465
Vavuniya	<i>t</i>	91.79	78.51	96.83	84.32
District	sig. (2-tailed)	.000	.000	.000	.000

However, conformist-seeking motive was identified as the least important form of motivation. A plausible explanation for the finding that conformist-seeking motivations were not important for the respondents in this research is that since these people living in urban areas, they pay less attention on common values of the society. They might not be interested in conforming to the norms of the society, in terms of conspicuousness.

The motives for conspicuous consumption between males and females were also measured. MANOVA was used to assess whether there were differences between these two groups. A significant difference was found (Wilks Lambda $\Lambda = 0.567$, $F = 67.321$, $p = <0.001$), between male respondents and female respondents in the importance they attach to different types of motives for the consumption of luxury products. Majority of male respondents identified luxury vehicles, wristwatches, and branded clothes as conspicuous products, while female respondents have recognized comfortable houses, gold jewelery, and high-priced clothes as their conspicuous products.

CONCLUSIONS/RECOMMENDATIONS

This research was carried out to explore the structure and nature of motives for the consumption of luxury products among the Tamil community in Vavuniya district. Based upon a review of the literature pertaining to motivation for consuming luxury products, four motives were identified. As revealed by the results, hedonic-seeking emerged as the most important motivation for the consumption of luxurious products for Tamil community. Conformist-seeking was the least important form of motivation. It implies that these people engage in conspicuous consumption in order to display their wealth and economic wellbeing to the society. Yet, they give comparatively less importance to status-seeking motives. This finding suggests that the conventional emphasis in the luxurious products literature, on status as a motivator of luxury consumption, may be misplaced.

The outcomes of this study provide some useful insights into what motivates ordinary people to consume luxurious products. Marketers can take these aspects into consideration when they plan their luxuriouss products, particularly for the Tamil community in Sri Lanka.

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A STUDY TO INVESTIGATE THE EFFECT OF THE VARIATION OF STITCH DENSITIES ON THE SEAM STRENGTH FOR A SELECTED FABRIC USING LOCK STITCH TYPE 301

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INTRODUCTION

The garments that people wear for different purposes 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). 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 et al., 2006). 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 the combination of them.

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. For the construction of different seams, different sewing parameters are used. In order to obtain high quality seams, correct sewing parameters should be carefully selected. One of the important sewing parameter is the stitch density. The variation of stitch densities may affect the strength of the seams. It is logical to think that with the increase of stitch density, the strength of the seams may also be increased.

The main objective of the research is to investigate the effect of the varying stitch densities on the seam strength.

METHODOLOGY

1. A literature survey was done to identify the factors, which could influence the seam strength.
2. A suitable testing standard, materials, machines and equipment were selected and the sewing parameters to sew the samples were determined.
3. Fabric samples (five samples each for warp and weft directions for each stitch density) were prepared for eleven (11) different stitch densities. The sewing machine speed of 2500 rpm was used to sew the samples.
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 variation of stitch densities has an impact on seam strength.

DESIGNING THE EXPERIMENT

The research is designed to test a particular woven fabric type with specific sewing parameters. The stitch densities were selected as per the seam optimization programme of Guetermann AG (Guetermann AG, 2000). The selected range of stitch densities covers the range covered in industrial practice. Though the stitching can be performed at different sewing speeds, 2500 rpm was selected for this experiment, which is the average speed used in the industry. It was ensured that the samples were made at the selected sewing machine speed by commencing stitching after the machine has reached the test speed. During the designing phase, the necessary materials, machines, equipment, stitching parameters and a suitable testing standard for the comparison purpose were selected as shown in the table 1.

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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 ^o , Relative Humidity: 65 ± 2%
Seam type	Plain seam
Stitch type	Single needle lock stitch
Sewing machine speed	2500 rpm

For the purpose of experiments, eleven (11) different stitch densities from 10 to 20 stitches per inch with an increment of one stitch per inch were selected. The range is limited to these values as the use of higher stitch densities may lead to structural jamming, where as the use of lower stitch densities may lead to seam grin. This is the only variable parameter of the experiment.

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 stitch density, 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. 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) loads and 1.0 lbf preload was used. The seam opening was 0.252 inches.

RESULTS AND DISCUSSION

Tables 2 and 3 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 2: Seam strength of samples – Seam parallel to weft direction

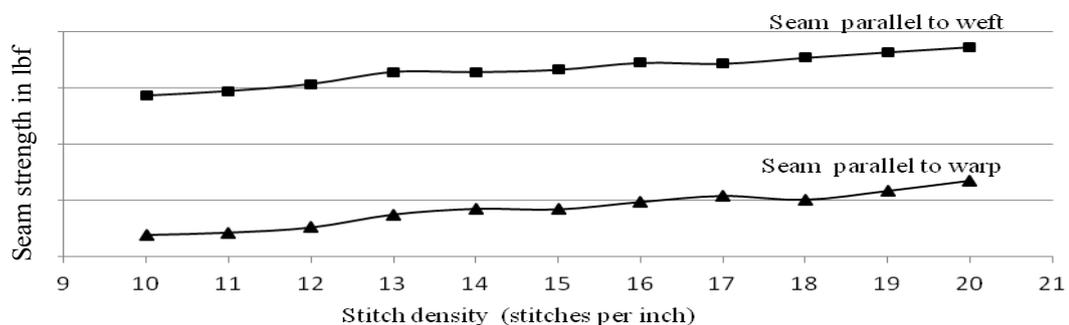
Stitch density (stitches per inch)	Average seam strength (in lbf)	Standard deviation	Coefficient of variation (%)
10	32.32	0.76	2.36
11	32.73	1.11	3.41
12	33.36	2.05	6.15
13	34.44	1.61	4.67
14	34.42	1.54	4.49
15	34.63	0.52	1.52
16	35.25	0.46	1.31
17	35.17	1.16	3.32
18	35.70	1.90	5.34
19	36.20	1.50	4.15
20	36.66	1.28	3.49

Seams parallel to warp direction**Table 3: Seam strength of samples- Seam parallel to warp direction**

Stitch density (stitches per inch)	Average seam strength (in lbf)	Standard deviation	Coefficient of variation (%)
10	19.91	1.26	6.37
11	20.12	1.49	7.41
12	20.58	0.85	4.14
13	21.74	0.89	4.13
14	22.25	1.25	5.65
15	22.19	0.30	1.36
16	22.86	1.42	6.21
17	23.40	1.47	6.28
18	23.06	1.10	4.81
19	23.85	1.53	6.44
20	24.76	0.80	3.27

The second column of tables 2 and 3 shows the average value of seam strength for each tested stitch density. The overall average value of seam strength for the selected stitch densities in the weft direction is 34.62 lbf, and in the warp direction is 22.24 lbf. The third column of tables 2 and 3 shows the standard deviation of each tested stitch density. The fourth column of tables 2 and 3 shows the percentage of coefficient of variation for each tested stitch density.

Figure 1 shows the results obtained for seam strength for different stitch densities, both in the seams parallel to weft and warp directions.

**Figure 1: Variation of the seam strength against different stitch densities**

The average strength of the seams parallel to weft direction is higher than the seams parallel to warp direction in the selected fabric. Figure 1 shows that there is a gradual increase in the seam strength with the increase of the stitch density for the range of selected stitch densities.

CONCLUSIONS AND RECOMMENDATIONS

The garment designers use different stitch densities to develop garments of good quality. The criteria for using different stitch densities is dependent on many factors such as nature of the fabrics, shape of the stitching lines (curved or straight), the length, appearance and position of the seams in the garments etc. The number of needle penetrations increases with the increase of the stitch density. That means the number of holes in the seam increases with the increase of the stitch density. On the other hand the number of interlacing points in the seam increases with the increase of stitch density. Therefore it is difficult to predict the combined effect of variation of number of holes and interlacing points in the seams on seam strength. As per the results obtained from the samples made parallel to the weft and warp directions, there is an increase in the seam strength with the increase of the stitch density for most of the selected stitch densities.

Therefore, based on the results of this research, it is possible to conclude that the variations of stitch densities have an impact on the seam strength within the selected stitch densities. This difference is

emphasized when the first (10 stitches/inch) and the last (20 stitches/inch) is considered. Therefore it is possible to recommend that appropriate stitch densities could be used for designing of garments to achieve the expected strength, appearance and the drape which are dependent on the stitch density.

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EMERGING TRENDS IN SRI LANKAN FASHION IN KOTTE PERIOD

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INTRODUCTION

A trend is considered to be a behavior that evolves into a relatively permanent change and usually longer lasting and indicative of a broader cultural shift. The sixteenth Century the Kotte era (1411-1597AD) marked a permanent change in Sri Lankan dress fashion. The Portuguese conquered the island and established their power gradually throughout the lowlands of Sri Lanka, including in Kotte. Their influences in political, economic, cultural and social strata were huge and directly affected the lives of the people of the society. By this time the royalty was directly inspired by Western sartorial trends that led to drastic changes in the way of the practicing traditions of Sri Lankan fashion forms. The royalty had direct contacts with Portuguese Kings and diplomats, and they embraced certain items of dresses, which was mixed and mingled with the traditional dress, and created a novel dress. The process of mingling, of mixing and matching of several dresses, details is called hybridization and shows a dramatic composition of Western, South Indian and Sri Lankan dress details. The objective of the paper is to explore in what ways emerged, sartorial complexities of dress composition emerged which entailed an eclectic fashion movement in Sri Lanka.

METHODOLOGY

The qualitative method was adopted for this research. A sequence of observational studies with temple paintings, wood, and ivory carvings, and sculptures, along with a continuous literature review that used original documented manuscripts, and published records, research and inscriptions were used to gather and sort data. Validation was confirmed by cross-checking with relevant literary sources.

RESULTS AND DISCUSSION

SINHALA ROYALTY GREW UNDER PORTUGUESE AND CONVERTED TO CHRISTIANITY

In comparison to the world movement of dress fashions, the Kotte period marked the culmination of an emerging new fashion trend among the royalty in succeeding eras in Sri Lanka, which was accompanied by unique features rooted in the Sri Lankan fashion culture. The historical narrations of Sri Lankan dress fashions of the royalties show that the religion of that particular society played a pivotal role in forming the ideology of the wearer. However, subsequent to the advent of the Portuguese in Ceylon in 1505 AD, the State religion was instrumental and changed the ideology of the royalty after their conversion to Christianity. In 1557 AD Prince Dharmapala (1551-1597AD the grandson of King Buwanekabahu VII of Kotte), was baptized with the name of Dom Joao Pareira Pandar (1557AD) (Pieris,1992). He educated under *Joao de Villa de Conde* (the chief of the seven members of Franciscans who visited Sri Lanka in 1543AD).The Portuguese names were the fashion at court. Baptism became a rebirth under a foreign name and every female royal convert was dubbed as Dona. To de-nationalize the race was not the missionary's object, yet such was the inevitable consequence of the course he pursued, for with baptism came a rebirth under a foreign name and every royal convert was dubbed a Dom.

It is noticed that most of the early kings of the Kandyan era were also educated under

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Portuguese Franciscans and baptized. King Wimaladharmasooriyal(1591-1604) was one of them; he was the son of a noble called Wirasundara Mudaliyar who was known among the Portuguese by the name of Dom Joao de Austria Mudaliyar. However, from his childhood he was known as Konappu Bandara. He embraced Buddhism after he became the King of the Kandyan Kingdom, as it was an important qualification for kingship. However, his personal desires and Western attitudes could not be eliminated from his dress sense. His enthusiasm for Western culture was clearly evident through early travelers’ notes, (Hulugalle, 1999). The dress habits of King Rajasimha 11(1635-1681) who was the son of King Senarath (1604-1635) who also grew up under the Portuguese, show how he changed his mind with the impact of the environment in which he had grown up .Knox’s statements are quite important to understand the King’s habits, which were displayed throughout his life- time. Knox says, that ‘he was not wont to keep to one fashion, but changes as his fancy leads him’ (Knox, 1958). Knox further observes, ‘his apparel is very strange and wonderful, not after his own country fashion, or any other, being made after his own invention’. (Knox, 1958)

ROYALTIES INTRODUCED NEW DRESS FASHION



Figure 1: Prince Dharmapala dressed like a Sinhalese and a Portuguese King on his coronation day in Lisbon (1540AD)

Figure 3: King Mayadunne
Figure 4: King Raigam Bandara (Uncles of Dharmapala)

Ivory Casket inv.no1241 rear view bottom right

Ivory Casket inv.no 1241, left gable



Figure 5: King Wimaladharmasuriya I (Silva&Beumer1988)

Figure 6: King Rajasimha II (Knox 1966)

As shown in Figure 2, it is believed that Prince Dharmapala introduced the long -sleeved long coat ‘cabaya’ for the upper body mixed with unstitched long wrapped cloth. Follow by him, his two uncles, King Mayadunne and Raigam Bandara, also adopted the short jacket for the upper body with the so- called wrapped cloth. Figure 5 shows King Wimaladharmasuriya I in a long – sleeved short jacket , a ‘hettaya’ known as a ‘juwanhette’, which derived its name from its introduction by Don JhonWimalaDharmasuriya I, (Codrington 1910). The long -sleeved jacket was also known as ‘kameesahettaya’, and a ‘mantehettaya’. The King’s dress is a

hybrid formation of Western and traditional Sinhalese dress details. It could be assumed that he composed the full dress according to his personal fashion consciousness. The full dress is completely different from the traditional royal dress code of earlier kings. From the eighteenth Century onwards, the royal dress changed to a long sleeved jacket and the long lower cloth and pantaloons (trousers) as depicted in wall paintings and sculptures of the period. It is obvious that the new dress style merged well into the tradition of the county. After King Vimaladarmasuriya I devised his own visual representation, some new associations emerged for the long sleeved -jacket. After this, the long- sleeved jacket could be seen as being associated with a new set of dress types. Successors of King Wimaladharmasuriya followed the same long- sleeved jacket with a collar or a '*tippet*' (Codrington, 1910), which was composed of trousers or *pantaloons*, and they became a fashion statement.



Figure 7:
King Kirithi Sri Rajasimha
(Dambulla temple)



Figure 8:
King Sri Wickrama Rajasimha
(Davy 1821)

King Kirithi Sri Rajasimha composed of loose, white pantaloons and the '*hette*' or jacket. This jacket was also known as a '*mojahette*' with a two- pieced frilled collar that was made in a rich material of brocade, velvet, silk or cloth of gold. The jacket had long sleeves and is presently well- preserved at the Kundasale temple in Kandy. King Sri Wickrama Rajasimha's royal dress, which is shown in Figure 8, was a continuous narration of dress etiquettes that was followed by the Nayakkar Kings. He wore loose pantaloons as a lower garment with two layers of frills attached to the ankle, and covered the upper body with a long- sleeved fine muslin jacket known as a *Watahette* or '*relikamise*'. Apart from the '*yatakamise*' or '*roppillios*' (foundation garment), he wore a fine muslin shirt as a '*udakamisaya*' or '*wambays*' (doublet or outer garment), which was sleeveless. Although King Sri Wickrama Rajasimha and Kirithi Sri Rajasimha were Tamil by birth they eventually embraced Buddhism and followed the fashions of former kings. Visual representations in temple murals show, in Figure 9- 14 how the kings were immersed in Western fashions and adapted them according to their contemporary social dress norms and values. They patterned the jackets with different types of sleeves, necklines, collars, fastenings, and decorative trimmings such as frills and ornamental cuffs with traditional designs and motifs.

TRENDY VARIATIONS IN MALE JACKETS DURING THE KANDYAN ERA



Figure 9
Gangaramaya temple, Lewella, Kandy

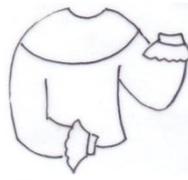


Figure 10



Figure 11
Degaldoruwa temple, Kandy



Figure 12



Figure 13
Hanguranketha temple, Kandy



Figure 14

HYBRID FASHION COMPLEXITIES IN ELITE MALE FASHION



Figure 15



Figure 16

**Higher administrative officers during the period of British rule in Sri Lanka
Early 20th Century**

Figures 15 and Figure 16 shows that the elite and the high rankers of the administrative society, during the early twentieth Century in the south of Sri Lanka, wore long coats with a long cloth up to the ankle and long trousers beneath the cloth. What is noticeable here is that instead of Prince Dharmapala's long coat and long lower piece of cloth, a new dress form, consisting of trousers worn beneath the cloth emerged. This new fashion brought an interesting dress composition and elaborated the perceptions of that society. The mode of the new dress composition signified 'smart gentleman'. It seems that with the passage of time, the elite male has ignored the lower cloth and practiced wearing a long coat and trousers. In this way, it seems that people in the society could continuously convey dress signifiers according to their wish. However, it is apparent that the culture of the society had ignored some dress forms, and had re-formed and adopted another dress for elite males in the middle phase of the twentieth Century in Sri Lanka.

CONCLUSIONS/RECOMMENDATIONS

It is realized that dress fashion in Sri Lanka has been a vibrant composition of succeeding administrative eras in history. The impact of the Portuguese on the dresses of the royalty caused a vibrant composition of dress. The novel dress mode, immediately inspired by the elite of the royal court led, to many other formations of components into dress. The so-called

traditional Sri Lankan dress became a blend of the Western and the Sri Lankan. However, the finalized dress fashions became more authentic than ever before. The cultural blend of a stitched long coat or a short jacket mixed with an unstitched wrapped long cloth gave immense visual impression for the viewer. The male dress of the early phase of the 20th Century, gradually built up its position steadily in society. The dress was identified as a strong symbol in social administration. This sartorial eclectic blend paved the way for emerging new trends among Sri Lankans. The main assumption of this exploration was that changing attitudes, in a socially accepted way, would benefit the evolving novel fashion of a society. This concept is derived from basis that would recommend the application of different avenues to the field of fashion. Therefore, the applicability of the fashion meanings of the Kotte period to the present, as well as to the future, is possible. The knowledge gained from the study can be applied to other fields of fashion, such as fashion advertising, fashion photography and fashion journalism. Contemporary society is valued based on a pecuniary culture. In this culture, dress and fashion have become the highest demanding consumer consumption product.

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PRACTICAL SOLUTION FOR UTILIZATION OF POLYESTER RESIN WASTE AS A FILLER IN RUBBER COMPOUNDS

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INTRODUCTION

For decades, the rubber industry has been using various fillers for making rubber products. A number of scientific publications were devoted to the study of the specific influence of rubber–filler interaction on properties of rubber compounds due to its crucial effect on all processing and performance characteristics (1, 2). The significance of this phenomenon was recognized a long time back and ways for the optimization and most efficient usage of fillers were found to be a long and difficult process. In the presented research paper our attention was brought to a new form of rubber industry filler. This filler is comprised of cross linked thermosetting polyester resin waste. Thermosetting polyester resins are usually used for applications where high mechanical properties are not required. Brandix Lanka Ltd. is one of largest users of polyester resins for manufacture of various buttons for cloth in number of garment factories in Sri Lanka, South Asia, South Africa and Europe. The buttons are made by forcing heated polyester sheet into the mould cavity, where it is heat treated. After hardening the formed buttons are trimmed out and the remaining part of the plastic sheet becomes an industrial waste as it cannot be reprocessed again. The hard cross-linked structure neither dissolves nor melts. At present Brandix Lanka Ltd. experiences a serious problem with disposal of cross-linked polyester resin waste as it is a non-renewable resource, not biodegradable and being thrown away, it just sits in the dump and never breaks down. Finding cost effective recycling solutions is increasingly important in polyester waste management not only in Sri Lanka but all over the world. According to European Union Directive (EU) automotive from end-life vehicles generates nine million tons of polyester waste per year (3). Taking into consideration the valuable properties of polyester resin, such as structural durability, compatibility with plastics and rubbers, low specific gravity, resistance to moisture and chemicals (4), it was decided to use finely ground polyester resin waste as a filler in rubber compounds.

METHODOLOGY

Materials

Emulsion Styrene Butadiene Rubber SBR 1502 supplied by Korea Kumho Petrochemical Co., Ltd was used in the experiments. As traditional semi-reinforcing filler precipitated granulated silica of Ultrasil VN3 grade supplied by GR of Evonik Degussa (SEA) Pvt. Ltd. was experimented. Calcium Carbonate having commercial name Lackarb 10 was locally manufactured by Lanka Minerals and Chemicals (Pvt) Ltd and was used as non-reinforcing filler. Polyester wastes in the form of finely ground powder having particle size below 5µm were received from Brandix Lanka Ltd. Other chemicals used for making rubber compounds are given in Table 1.

Preparation of rubber compounds

All rubber compounds were prepared using a laboratory scale internal dispersive mixer and two roll mill manufactured by Moriyama Manufacturing Works Ltd, Osaka, Japan. Compounding of master batch was done in two stages according to mixing schedules given

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in Tables 2 and 3. After discharging the first stage master, compound was left for at least 12 hours for maturation. In 12 hours first stage master compound was mixed with required ingredients to obtain second stage master, which also was left for 12 hour maturation. On completing maturation, the compound was sulphured in an open two roll mill (Table 4).

Table1. Formulations of rubber compounds

No	Ingredients	F-1, pphr	F-2, pphr	F-3, pphr
1.	SBR-1502	100	100	100
2.	Zinc oxide	5	5	5
3.	Stearic acid	2	2	2
4.	Antioxidants	1	1	1
5.	Silica	50	0	0
6.	Calcium carbonate	0	50	0
7.	Polyester	0	0	50
8.	PEG	4	0	0
9	Si-69	0.4	0	0
10	Zincolet pn-60	1.0	1.0	1.0
11	Sulfur	2.5	2.5	2.5
12	MBTS	2.0	2.0	2.0
13	TMTD	0.2	0.2	0.2
	Total	168.1	163.7	163.7

Table 2 .Mixing Cycle for preparation of first stage master compounds.

Cycle time, min	Procedure for F-1compound	Procedure for F-2 and F-3 compounds
0	Add rubber	Add rubber
2	Add Stearic acid, 40 pphr Silica, Si-69,PEG , Zincolet pn-60	Add Stearic acid, 40 pphr Filler, Zincolet pn-60
6	Dump	Dump

Table 3 .Mixing Cycle for preparation of second stage master compounds.

Cycle time ,min	Procedure for F-1compound	Procedure for F-2 and F-3 compounds
0	Add first stage master compound	Add first stage master compound
2	Add 10 pphr silica, antioxidants, zinc oxide	Add10 pphr filler ,antioxidants, zinc oxide
4	Dump	Dump

Table 4 .Mixing Cycle for preparation of third stage sulphured compound.

Cycle time ,min	Procedure
0	Add second stage master
2	Add Sulphur, MBTS, TMTD
4	Sheet out

Determination of physical and mechanical properties of prepared rubber compounds. Cure characteristics were measured using a MONSANTO ODR 2000 rheometer according to

the procedure given in ISO 3417:1977 (E) standard. The samples were vulcanized to their respective cure time in a laboratory type "MOORE" hydraulic press preheated up to 150 °C along with plates. After de-moulding and cooling, the specimens were punched out of cured rubber sheet, cooled and conditioned at least for 3 hours at temperature of $23 \pm 2^\circ\text{C}$ prior to testing. Physical properties like hardness, abrasion resistance, rebound resilience, specific gravity, tensile strength, ultimate elongation and modulus at 100 % and 300% elongation were measured according to appropriate standard. Bound rubber content was determined by extracting the unbound material with toluene for seven days and drying for about two days at room temperature until there was no further weight reduction observed. Weight of the sample before and after extraction was measured and bound rubber content was calculated.

RESULTS AND DISCUSSION

Cure characteristics given in Table 5 showed, the scorch times, t_{10} corresponding to 10% cure were approximately at the same level for all compounds. It was a little shorter for polyester filled compound, while the optimum vulcanization time t_{90} , corresponding to 90 % cure was longer comparing to calcium carbonate filled compound and less when compared to the same of silica filled one. These results can be related to the fact that polyester filler accelerated vulcanization rate of rubber compound. Vulcanization characteristics such as minimum torque T_{\min} was lower when compared to silica filled compound but above that of calcium carbonated filled one. Minimum torque is associated with the viscosity of green rubber compound, that has a great influence on processing and performance properties of rubber compounds. Increase of viscosity will increase time of sheet formation, mixing temperature and green strength (5). Better green strength of polyester filled compound is a good indication of processing behavior. It is a particularly important for the rubber stocks that are used in solid tire manufacture where resistance to deformation and fracture before vulcanization is crucial. The difference between maximum torque T_{\max} and minimum torque T_{\min} attributed to the cross-links density, that was found to be better for polyester filled compound when comparing with calcium carbonate filled one, but lower as compared to silica filled compound. As expected the maximum torque was obtained for compounds containing semi-reinforcing silica. Formation of chemical bonds between rubber and silica through application of coupling agent contributed to cross-links density thereby resulting in maximum torque values. Polyester filled compound showed higher Shore A hardness value, better tensile strength and elasticity modulus at 100% and 300% elongation, improved abrasion resistance and rebound resilience when compared to calcium carbonate filled compounds (Table 6). However silica filled compounds demonstrated superior properties. One advantage of polyester filled compound over semi-reinforcing silica filled one was low specific gravity, that is a decisive factor for some rubber products. Rebound resilience is the property of absorbing energy by deformation and returning a proportion of it on rebound. This property is mainly related to elasticity of rubber compounds and inert soft fillers give particularly good results. Increase in temperature facilitated oxidation processes in rubber and major degradation took place in compounds filled with calcium carbonate and polyester. Bound rubber content test was performed to find amount of rubber that can no longer be separated from the filler surface with solvent (6). As bound rubber content was significantly reduced, there were no chemical bonds formed between rubber molecules and polyester filler. Achieved improvement in properties could solely be attributed to better compatibility of polyester with rubber compared to calcium carbonate, resulting in better absorption of rubber fragments by filler surface.

Table 5 Cure characteristics

No	$t_{10,\min}$	$t_{90,\min}$	$T_{\min}, \text{lbf}\cdot\text{in}$	$T_{\max}, \text{lbf}\cdot\text{in}$
F-1	1.59	2.60	13.50	78.80
F-2	1.60	2.59	9.80	50.50
F-3	1.47	2.20	11.4	61.30

Table 6. Properties of rubber compounds

Property	F-1	F-2	F-3
Modulus of elasticity at 100% elongation (MPa)	2.8	2.0	2.3
Modulus of elasticity at 300% elongation (MPa)	8.5	9.8	12.5
Tensile strength (MPa)	25.0	12.0	16.2
Elongation at break ,%	650	360	400
Hardness (Shore A)	64	63	66
Specific gravity,g/cm ³	1.25	1.30	1.18
Rebound resilience,%	52	45	48
Abrasion resistance, mm ³	130	185	175
Tensile strength after heating at 100°C for 72 hrs (MPa)	15	8.2	8.1
Elongation at break after heating at 100°C for 72 hrs,%	340	120	190
Bound rubber content,%	65	11.0	11.5

CONCLUSIONS

It was possible to mix thermosetting polyester resin waste left over after buttons manufacturing process with rubber compounds using traditional mixing equipment and application of standard mixing procedure.

Properties of rubber compounds filled with polyester resin showed definite advantages when compared to properties of compounds extended with non-reinforcing calcium carbonate filler.

There was no chemical bond between rubber and thermosetting polyester resin.

Improvement in properties was achieved on account of better compatibility of rubber and polyester resulting in better physical interaction between them.

This work suggested that thermosetting polyester resin waste could be used as filler for rubber compounds.

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REVERSE ENGINEERING OF AN AUTOMOTIVE SUSPENSION STRUT MOUNT

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INTRODUCTION

Rubber strut mounts are used to attach the suspension struts to the vehicle frame. The dynamic properties of a rubber strut mounts are dependent on several variables, such as loading frequency, amplitude, preload, and temperature [1,2]. To get a higher level of durability, good vehicle handling, and rider comfort in an automobile, the performance of strut mounts are very important. Their most critical function is that they act as a noise and vibration absorbing barrier between the road and the car [2]. Since rubber is vulnerable to heat, chemicals, and external contaminants over time, the performance of the strut mount will degrade over time. This will cause vibrations and noises to emanate from the connection points of the suspension system, and can also affect steering response and rider comfort [2].

Though strut mounts are technically easy to manufacture, their performance needs should be carefully engineered though a compound design to achieve satisfactory performance. Strut mount compounds designed to perform at lower ambient temperatures, as those that exist in tropical environments, would fail prematurely, especially when exposed to poor road surfaces[4].

The development of rubber compounds by reformulation, to enhance the qualities and performance of the product, has been a popular trend in the rubber industry. In the rapid growing markets of today, introducing products with better features at a faster rate is vital for the survival of the manufacturer. This is often done by studying an existing product in order to gather information about the characteristics and making improvements as and when required. This is known as reverse engineering [3].

OBJECTIVE

The objective of this research is to analyze the rubber compound of a failed automotive strut mount to determine its shortcomings in order to alleviate them. This study also expects to investigate the possible means of improving the performance of the compound by reformulation.

METHODOLOGY

1. Chemical analysis of a strut mount specimen

1.1. Identification of base rubber

The rubber extraction process was carried out according to ASTM D 297 standards. A fine specimen of vulcanized compound was extracted with acetone for 16 hours to isolate the base polymer residue and an FTIR analysis was performed on it to identify the base polymer.

1.2. Identification of Acetone soluble ingredients

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A part of the extract was dried at 105⁰C for 30 minutes. The residue of the dried extract was used to perform an FTIR analysis for the identification of plasticizers.

1.3. Quantification of Carbon black content in compound

The determination of the carbon black quantity was carried out according to ASTM D 297 and ISO 1408 standards. The acetone extract residue was placed in a combustion boat and was heated at 850⁰C in an argon-rich atmosphere. After measuring the weight of remaining carbon, it was burnt off in a muffle furnace at 850⁰C in an oxidizing atmosphere. The latter was performed to estimate the inorganic matter content.

1.4. Quantification of main ingredients in a strut mount compound

A thermo-gravimetric analysis was carried out according to ASTM D 6370 standards to estimate the organic content, carbon black content and ash (inorganic matter) content.

1.5. Determination of ash content of the compound

An Ash test was carried out according to ISO 247 standards. A weighted portion of the vulcanized compound specimen was heated in a crucible in a muffle furnace at 850⁰C for approximately 4 hours until all carbonaceous matter was burnt off and a constant mass was attained, after which it was measured.

2. Reformulation the rubber strut mount recipe

A probable recipe could be reformulated by considering the results obtained from the chemical analysis. The ingredients that were difficult to identify and estimate were determined experimentally by trial formulations.

3. Compounding

The batch was compounded according to the reformulated recipe. Carbon black was used in both types N660 and N330 since the type of original carbon black could not be determined and the effect of carbon black type on spring properties had to be identified. Since the accelerator type could not be clearly identified by the available analytical methods, both the TMTD and MBTS were used as accelerators. The trial formulae used for the compound design are shown in Table 1.

Table 1. Trial formulae

	Trial Compounds (in phr)						
	1	2	3	4	5	6	7
NR	100	100	100	100	100	100	100
N660	-	30	-	40	30	-	-
N330	30	-	40	-	-	30	30
ZnO	1.5	1.5	1.5	1.5	3	3	5
Stearic acid	3	3	3	3	3	3	3
Sulfur	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Process oil	5	5	5	5	5	5	5
MBTS	1.25	1.25	1.25	1.25	-	-	1.25
TMQ	1.5	1.5	1.5	1.5	1.5	1.5	1.5
TMTD	-	-	-	-	0.5	0.5	-

A series of compounds series were prepared by changing the Carbon black/accelerator type and changing the loading of carbon black, ZnO, MBTS and TMTD. This was carried out to estimate the original formulation, as well as to improve the key properties required. Then an un-vulcanized rubber compound was first tested to obtain its curing characteristics using a

rheometer (TOYOSEKI®, Japan). The specimens were made using a Hydraulic press - SECO/317/06-07 at 150°C and 13.7Mpa pressure. For different tests different specimens were moulded using relevant moulds. Cylindrical disk-shaped specimens (buttons) were moulded for compression set, rebound resilience, hardness and specific gravity tests. Dumb bell-shaped specimens were cut using a cutter from a moulded rubber slab and rubber strips were moulded for fatigue testing.

4. Physical Testing

Physical properties of vulcanized rubber compound, namely, hardness, specific gravity, abrasion resistance, rebound resilience, compression set, apparent modulus and shear modulus measurements, were carried out for rubber test specimens according to the relevant ISO standards.

RESULTS AND DISCUSSION

The rubber sample (residue) obtained after extraction was used to identify the base rubber in the strut mount. By comparing the resultant peaks with the standard FTIR peaks, the main base polymer was identified as Natural rubber

Table 2 shows the results of the analysis of the original compound. Table 3 shows the estimated formulation according to the results of the analysis of the original compound. According to the quantity of ZnO detected and the measured amount of molecular weight between cross links, the accelerator system was estimated. FTIR analysis of the acetone extract suggested the presence of MBTS in the compound. The quantity of carbon black was measured as described. However, analysis was not performed to determine the type of carbon black. It was expected to estimate the exact quantities of the formulation by fine-tuning the compound by experimentation [3,7]. The weights of individual ingredients were slightly altered to be on par with commercial formulations of similar products.

Table 2. Chemical and physical analysis of the reference compound

Parameter	Method	Test Result	Parameter	Method	Test Result
Polymer Type	FTIR	Natural Rubber	Density	ASTM	1.000
Polymer Quantity	TGA	60.67%	Hardness	ASTM D 1415	IRHD 61
Carbon Black Quantity	TGA	30.32%	Rebound Resilience	ASTM	74%
Carbon Black Quantity	Pyrolytic method	24.7%	Compression Set	ASTM D 395-03	22.76%
ZnO	ASTM	4.27%			

When considering the physical test results obtained from the original specimen, they show a little deviation from the values that should have been demonstrated for such a type of compound. This would be due to the degradation of the sample as this strut mount has been in service for approximately three years.

Table 3. Estimated formulation

Ingredient	Formulation (phr)
NR	100
ZnO	1.5
Stearic Acid	3
Carbon Black	30
Sulphur	2.5
Process Oil	5
MBTS	1.25
Anti Oxidant	1.5

One of the major difficulties in determining Young's modulus, in either tension or compression, is its sensitivity to previous deformation. Rubber, especially when filled with reinforcing carbon black, softens when first deformed. Most of the change occurs during the first deformation, but small changes may still be detectable after many cycles[5,6].

The most dominant properties, which are to be considered when designing a spring rubber compound, are compression set, rebound resilience and loss tangent (the variation of rebound resilience and compression set is shown in figure 1). It is because they directly measure stress relaxation/elasticity, energy recovery and heat-buildup of the rubber compound. Since this spring rubber compound is designed to manufacture a shock absorber strut mount, better dynamic properties of the compound are important for better performance of the end component.

From the data in Table 4, it could be seen that compounds that having the N 660 type perform better as a spring compound. Also, the increase of carbon black loading (N660) showed improvement in resilience, loss tangent and tensile strength. Since the increase of carbon black content could lead to a loss of resilience and an increase in hardness and loss tangent, a further increase of carbon black was deemed infeasible [5].

The compound that used TMTD showed better spring properties, such as lower loss tangent and higher rebound resilience. Increasing accelerator loading showed improvement of the spring rubber properties, such as compression set, harness, rebound resilience and low loss

Table 4. Physical properties of trial compounds

Sample Number	1	2	3	4	5	6	7
300% Modulus (MPa)	19.68	16.27	18.19	21.04	23.24	24.3	23.59
Tensile Strength(MPa)	31.25	20.34	21.27	22.42	22.58	24.89	27.67
% elongation at break	384.7	337.3	328.5	309.3	300.2	305.8	324.0
Hardness (IRHD)	49.0	44.0	48.5	53.1	53.2	52.5	51.9
Molecular weight between Crosslink(g/mol)	38423	39050	24061	26089	23766	29498	34037
Rebound resilience (%)	66	65	61	67	74	69	68
Specific Gravity	0.75	0.721	0.721	0.757	0.743	0.742	0.742
Compression set %	9.04	11.35	10.16	12.14	9.14	13.50	14.60
Loss tangent	0.1322	0.1371	0.1573	0.1274	0.0958	0.1181	0.1227

When the physical properties of samples are compared, sample number five showed outstanding enhancement of basic spring rubber properties. Therefore, it can be identified as the best spring rubber.

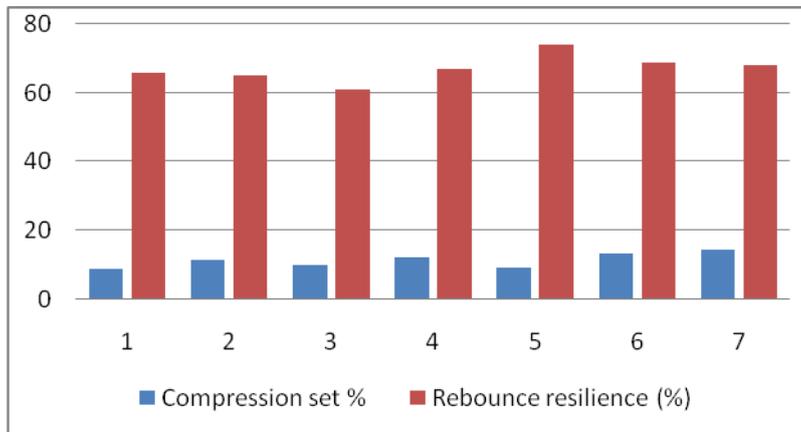


Figure 1: Variation of rebound resilience and compression set

CONCLUSIONS

It can be stated that Carbon black N660 is a better filler than carbon black N330 to obtain good spring properties in a rubber compound. TMTD is an accelerator that gives a higher curing rate and improves spring properties than MBTS.

The sulfur loading in a rubber compound is critical and would have to be performed in a manner to optimize resilience and to minimize heat build-up. As such, it was not thoroughly investigated in this study, but it was concluded that the outcome of a TMTD-based system was better suited, based on the observed properties.

Based on the performance evaluated, the compound No. 5 (Table 1) can be concluded as the best suitable for the application. However, its performance requirements, as per the ASTM D2000 (Standard Classification System for Rubber Products in Automotive Applications), needs to be established after further improvements in its mechanical properties.

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COMPARISON OF BURSTING STRENGTH VARIATIONS OF COTTON/SPANDEX AND COTTON SINGLE JERSEY AND 1X1 RIB KNITTED FABRICS

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INTRODUCTION

Knitting, which is one of the fabric production methods other than woven and non-woven, is mainly used with weft knitted and warp knitted fabrics. Both are very popular in textile and apparel applications. Mechanical characteristics of knitted fabrics are very essential in various application fields as well in downstream processes. Among the mechanical characteristics of knitted fabrics, bursting strength is of great importance for the weft knitted fabrics, which are exposed to multi axial forces during the usage such as certain applications in apparel field, parachutes, filtration fabrics and sacks, [mavruz (2010), Ertugrul&Ucar (2000) and Herath (2008)]. For this reason, estimating the bursting strength of knitted fabrics before manufacturing products is very important. As the weft knitted structures are constructed in 3D form, its fabric strength is usually measured using the bursting strength test, where the bursting force is applied on to the sample three dimensionally [Ertugrul&Ucar (2000)]. During relaxation treatments, knitted fabrics tend to go back to a minimum energy state releasing internal stresses, which changes the stitch configuration, stitch lengths and all structural parameters such as wale/cm, course/cm, stitches/cm² etc. and this significantly affects the fabric performance [Ertugrul&Ucar (2000), Herath (2008) and Marmarali (2003)] However, it was reported that yarn type and material type, relaxation treatment and stitch length are significantly effective factors for the variations of bursting strength of weft knitted fabrics [mavruz (2010), Ertugrul&Ucar (2000) and Marmarali (2003)].

This paper is focused on the comparison of bursting strength variations of core spun cotton-spandex and 100% cotton single jersey and 1x1 rib knitted fabrics with three tightness factors under relaxation treatments up to 5th washing cycles.

METHODOLOGY

Materials

100% Cotton (abbreviation: CO) and core spun cotton/spandex (abbreviation: CO/SP) with 93% cotton and 7% spandex were used to knit single jersey and 1x1 rib structures in a circular knitting machine in high, medium and low tightness factors (TFs). In order to achieve the 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 making knitted fabrics. Spandex filaments with 40dtex were used in producing of core spun cotton-spandex yarns. Table 2 gives the knitting details of single jersey (plain) and 1x1 rib structures.

Table 1: Knitted yarn characteristics

	Nominal Count [Ne]	Tenacity [cN/tex]	Breaking elongation [%]	Yarn twist [tpi]
CO	30*	18.217	5.04	19.7
CO-SP	30*	15.245	8.94	27.4

*Measured count of 100% cotton yarn is 20.14tex and That for cotton/spandex yarn is 20.40 taxes

Table 2: Knitting details

	No. of feeders (positive)	No. of needles
Plain	72	2640
1X1 rib	60	1680

Note: Machine diameter=30 inches; gauge=24 and machine RPM=20

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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 of 1x1 rib structures, 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 of the stitch lengths required to knit face/reverse stitches.

Table 3: Machine set and machine off stitch lengths in cm.

Structure	Material	Low fabric tightness [L-TF] stitch length(cm)	Medium fabric tightness [M-TF] stitch length(cm)	High fabric tightness [H-TF] stitch length(cm)
Plain	CO/SP	0.29 (0.268±0.020)	0.27 (0.255±0.012)	0.25 (0.240±0.010)
	CO	0.29 (0.284±0.021)	0.27 (0.262±0.032)	0.25 (0.242±0.041)
1x1 Rib	CO/SP	0.29 (0.266±0.053)	0.27 (0.244±0.054)	0.25 (0.231±0.066)
	CO	0.30 (0.293±0.041)	0.28 (0.271±0.050)	0.26 (0.251±0.051)

Note: TF(TF)=√tex/stitch length or SCSL (tex^{1/2} cm⁻¹)

Procedure

Sample size of 30x30 cm² were cut from 100% CO and CO-SP single jersey and 1x1 rib knitted fabrics. Six samples were cut from each TF of each CO and CO-SP single jersey and 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 5 cycles. Duration of tumble drying for single jersey and rib fabrics were 60 min. and 90 min., which was decided based on the literature survey results and preliminary testing to obtain complete relaxation of the knitted structures. In order to determinethe stitch density, loop shape factor, course and wale densities and loop length variations were measured with standard procedures. Bursting strength test was carried out using standard hydraulic diaphragm type bursting strength tester according to the ASTM D 3786. In this test, hydraulic pressure of 20kg/m²and diaphragm with 50cm²&2mm thickness were used.

RESULTS AND DISCUSSION

Bursting strength variations of single jersey and 1x1 rib knitted fabrics under relaxation treatments are shown in figures 1 and 2.

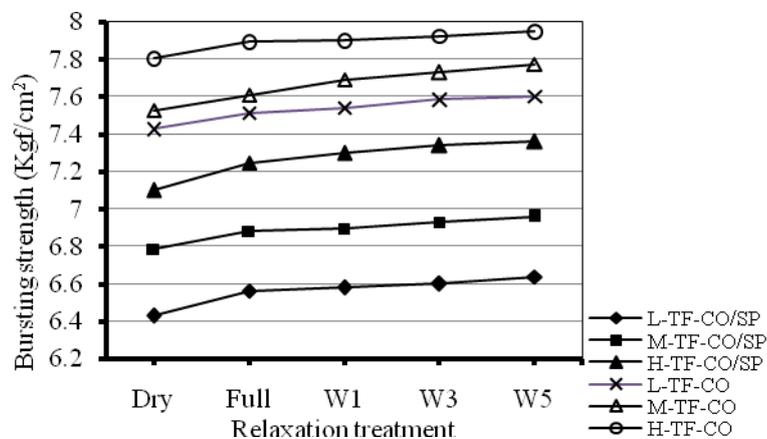
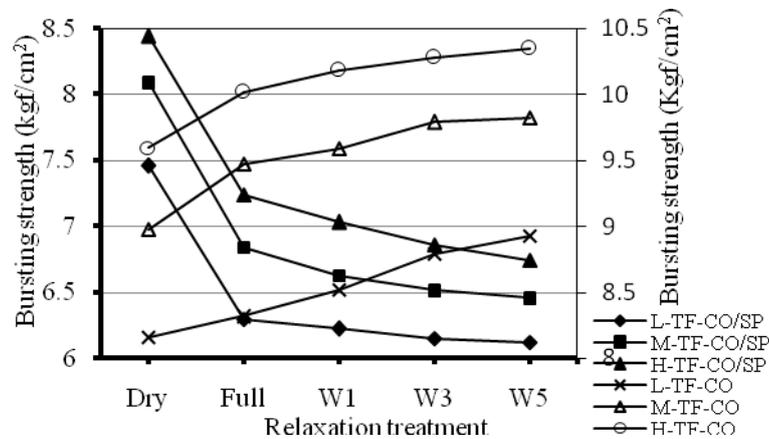


Figure 1: Bursting strength variations of single jersey fabrics under treatments

It shows that higher bursting strengths are given by higher tightness factor fabrics. That means bursting strength is proportionate to stitch length⁻¹. Thus, bursting strength increased with the relaxation of knitted structures during progressing of treatments except CO/SP rib fabrics, which have tumbled dried for 90 min. at 70°C. In this period, soft segments in

polyurethane (PU) molecules with lower glass transition temperatures may have phase transformation.

Due to this, modulus and strength of CO/SP yarns can be reduced with tumble drying done at each relaxation stage from full relaxation to W5. Hard segments of PU have higher melting point such as 190°C, which does not affect by repeated tumble drying. But, in CO fabrics, this change may not happen due to the lower duration of tumble drying. Meanwhile, dry relaxation to full relaxation show steeper increase of bursting strength than during progression of washing treatments (W1-W5). Because, in this period, structural parameters increase rapidly and results higher stitch densities for both knitted structures [Herath (2008)].



Note: Primary Y axis: for CO/SP and secondary Y axis: for CO

Figure 2: Bursting strength variations of 1x1 rib fabrics under treatments

However, CO single jersey and 1x1 rib fabrics show higher bursting strengths than CO/SP fabrics at all relaxation stages. This would be due to the higher tenacity of CO yarns as given in table 1 and higher machine off stitch lengths of CO fabrics, which can bear higher multi axial forces. But, According to the stitch density variations shown in figure 3 and 4, CO fabrics gave the lower stitch densities than CO/SP fabrics at all treatment stages. According to the stitch density variations given in figures 3 and 4, CO fabrics gave lower stitch densities compared to CO/SP single jersey and 1x1 rib fabrics. Furthermore, knits with lower stitch densities may not withstand higher multi axial forces and therefore, CO fabrics may burst at lower bursting forces. But, as per the figure 1 and 2, the effect of stitch densities has been overrun by the effect of yarn tenacity and higher machine off stitch lengths.

Thus, another reason would be the reduction of modulus and strength of CO/SP yarns during tumble drying in full relaxation to 5th washing cycle (W5) as mentioned. In addition to that, it was observed that diaphragm raising height of the machine for CO/SP fabric is much closer to its maximum limit at burst and for CO fabrics; it is about 40%-50% from the maximum limit. Because, breaking elongation of CO/SP yarns are higher than that of CO yarns as given in table 1. Thus, according to figures 1 and 2, CO rib fabrics gave higher bursting strengths than CO single jersey fabrics. Because, due to the higher machine off stitch lengths of CO rib fabrics (table 3), higher tenacity of CO yarns (table 1) and also two planar construction, 1x1 rib CO fabrics can bear more multi axial forces than CO single jersey fabrics. Thus, table 4 shows the summary of ANOVA for bursting strength variations under relaxation treatments in order to find out the significant effect of TFs and relaxation treatments, under 95% significant level. It shows that fabric TFs and relaxation treatments affect significantly on the bursting strength of fabrics, under 95% significant level.

Table 5 and 6 show the fabric area density (GSM) and loop shape factor (LSP) variations have given. It shows that GSM and LSP are positively correlated with the stitch length⁻¹ and increased with progressing treatments. More GSM means more stitches per unit fabric area,

which can bear more bursting forces. Thus, changing loop shape configuration may cause to bear more multi axial forces during bursting test.

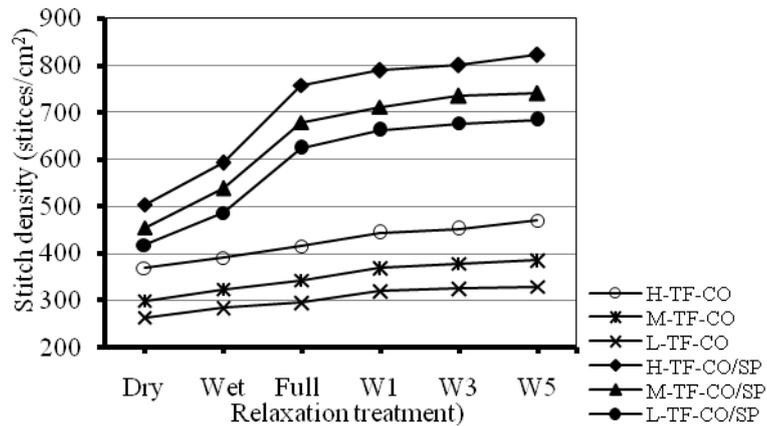


Figure 3: Stitch density variations of CO/SP and CO single jersey fabrics

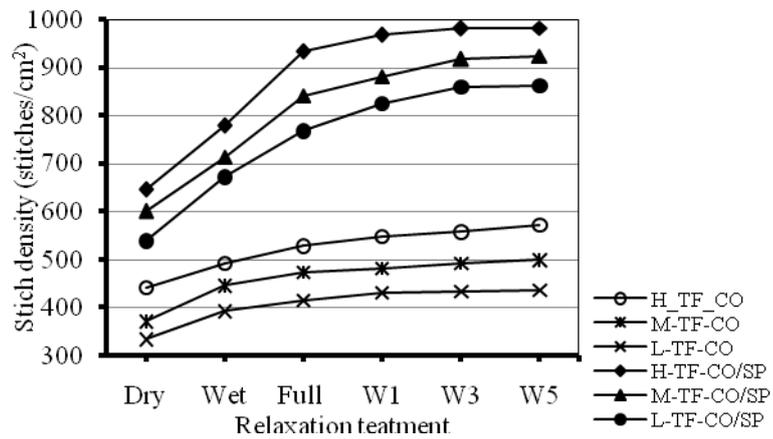


Figure 4: Stitch density variations of CO/SP and CO 1x1 rib fabrics

Table 4: ANOVA for the effect of TFs and relaxation treatments for bursting strength

Structure	Material	F _{actual} between relaxation	F _{0.05}	F _{actual} between TFs	F _{0.05}
Single jersey	CO/SP	44.641(p<0.0001)	5.87	1362.959(p<0.0001)	19.43
	CO	24.519(p<0.0001)		252.117(p<0.0001)	
1x1 rib	CO/SP	176.721(p<0.0001)		117.874(p<0.0001)	
	CO	47.372(p<0.0001)		486.082(p<0.0001)	

Table 5: Fabric weight density (GSM) and loop shape factor (LSP) variations of tested samples from Single jersey fabrics

Fabric type	TF	GSM (gm ⁻²)			LSP		
		Dry	Full	W5	Dry	Full	W5
Single jersey CO/SP	L-TF	235.59	309.2	333.42	1.66	1.83	1.86
	M-TF	237.58	311.81	341.67	1.76	1.85	1.87
	H-TF	240.42	313.28	363.45	1.82	1.86	1.91
Single jersey CO	L-TF	154.69	167.1	172.57	1.57	1.48	1.50
	M-TF	157.29	176.48	184.55	1.74	1.49	1.52
	H-TF	168.14	193.66	201.56	2.05	1.52	1.56

Table 6: Fabric weight density (GSM) and loop shape factor (LSP) variations of tested samples from 1x1 rib fabrics

Fabric type	TF	GSM (gm ⁻²)			LSP		
		Dry	Full	W5	Dry	Full	W5
1x1 rib CO/SP	L-TF	270.57	400.35	429.73	1.76	2.14	2.28
	M-TF	280.38	409.81	437.15	1.79	2.21	2.28
	H-TF	286.37	419.09	440.36	1.84	2.26	2.31
1x1 rib CO	L-TF	192.53	225.87	228.56	1.30	1.42	1.49
	M-TF	196.09	245.05	250.61	1.42	1.52	1.58
	H-TF	207.29	252.08	260.68	1.51	1.58	1.65

CONCLUSION

Bursting strength depends on the material and structure type. It is positively correlates with stitch length⁻¹ and increases with relaxing the structures. But, rib CO/SP has opposite behavior. CO knitted structures have higher bursting strengths than their CO/SP structures. Thus, increasing stitch density with fabric TF and fabric relaxation can give considerable effect on bursting strength. Increasing GSM and LSP with the fabric TF and fabric relaxation may also positively impact on bursting strength of single jersey and 1x1 rib CO/SP and CO fabrics.

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