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The Open University of  
Sri Lanka

# OUSL Journal

**Volume 13 No. 2**  
**December, 2018**

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*Climate, Energy and Education*

**Torsten Henry Fransson\***

## Editorial

This is the Volume 13, Number 2 of the OUSL Journal of 2018, the Journal of The Open University of Sri Lanka which is published biannually. The articles published in this Volume include: research based on Legal Studies, Education, Agriculture, Health Sciences, Ecology and Civil Engineering.

The emergence of the electronic commerce has transformed traditional consumer markets into a digital one within a few decades. In other words, the development of the internet and e-commerce has drastically changed the medium of transactions for traditional consumers. The paper titled *Protection of Consumer Rights on the Internet: Prospects and Challenges for the Sri Lankan Legal System* explores the concept of consumer rights and its application in electronic transactions. The author emphasizes that, due to the complex nature of the internet, online consumers have to face serious violations of their consumer rights. In such a context, the state intervention is very much important to safeguard the consumer rights in the digital environment. This paper argues that, even though Sri Lankan legislature has enacted several legislations in order to accommodate e-commerce and electronic transactions in Sri Lanka, those legislations fail to specifically address the issue of consumer rights protection in an online context. In order to highlight this lacuna in the Sri Lankan legal framework, this paper compares and contrasts the existing Sri Lankan legal regime with International and European Union approaches. Based on the findings of comparative analysis, this paper further emphasizes the need for an adequate online consumer protection mechanism embedded into the Sri Lankan legal landscape.

The research study titled *Flaws in Research Report Writing: An Evaluation of Research Reports Submitted for an International Conference on Education* investigates the flaws in research report writing by evaluating research reports submitted for an international conference on education. The study uses research report reviewers' evaluation forms to evaluate the quality of the research reports. The findings show that improper focus on the research objectives and

non-indication of gaps in knowledge, lack of attempts to critically critique the method(s) used in previous studies, inadequate description of research designs, non-self-explanatory tables and figures and lack of discussion about the significance and implications of results are the major flaws associated with those research reports. The study recommends that concerted efforts should be made by education faculties to organize faculty seminars where research report can be presented for constructive criticism. Also, the study recommends that universities and research institutions should endeavor to reward researchers for quality rather than quantity of their publications.

Turmeric is widely used as a medicine, condiment, dye, disinfectant and cosmetic. These plants need potassium for higher yield. The authors of the research paper, *Effect of partially-burnt Paddy Husk as a Supplementary Source of Potassium on Growth and Yield of Turmeric (Curcuma longa L.) and Soil Properties* investigate the effect of partially-burnt paddy husk as a supplementary source of potassium for growth and yield of turmeric and soil properties. Seven treatments were prepared by using two sources of potassium, namely Muriate of Potash (MOP) and partially-burnt paddy husk (PBPH) for local type of turmeric cultivation. Results revealed that combined use of MOP (100%) with PBPH (50%) has beneficial effects on turmeric cultivation. Paddy husk is a common plant residue in paddy cultivation and freely available potassium source. Partially-burnt paddy husk can be used as a supplementary source of potassium for turmeric cultivation to maximize the harvest.

Breast cancer has become the most common cause for cancer deaths among women worldwide. Delay in seeking medical advice for breast cancer causes increased morbidity, mortality and decreases the survival rate of these patients. The study, *Perceived Factors Related to Delayed Presentation of Breast Cancer among women with Stage III and IV Breast Cancer in Sri Lanka* was conducted to examine the perceived factors related to delaying of treatment for breast cancer among women. One hundred and fifty-one female patients with breast cancer stage III and IV, admitted to the Oncology ward and Oncology clinic of the Teaching Hospital, Kandy, were purposively recruited for this quantitative descriptive study. The study results

highlighted that majority of patients have not known about the symptoms of breast cancer. Further, about one third of patients delayed treatment due to the perceived embarrassment at exposing their breasts to medical practitioners and fear of partner abandonment. Significantly, four thirds of the patients were not aware of self-breast examination method and never attended the ‘Well Women Clinic’, which is conducted for the improvement of women’s health. Interestingly, majority of the patients did not have family histories of breast cancer. Therefore, establishing an effective public awareness programs is vital to increase early diagnosis, prognosis and survival rate and improve overall quality of life of patients with breast cancer.

Mangrove communities are usually characterized as efficient in carbon sink in tropical and subtropical coastal areas of the world. Sequestered organic carbon occurs both in standing plant biomass as well as in below-the-ground root biomass and mangrove soils. Data on total carbon storage in whole mangrove ecosystems assist pragmatic evaluation of ecological value of mangroves and justify their conservation and management. Lacks in quantitative data on carbon retention capacity of Sri Lankan mangrove ecosystems compelled the authors of the paper titled *Ecosystem Carbon Stock of Mangroves at the Batticaloa Lagoon, Sri Lanka* to carry out a study with the objective of estimating the total ecosystem carbon content in mangrove ecosystems in the Batticaloa lagoon, which is the largest lagoon situated on the east coast and the third largest brackish water system in the country. The total organic carbon content of mangrove ecosystems in the Batticaloa lagoon was calculated to be 506 Mg C ha<sup>-1</sup>. Mangrove soils that sequester 68% of the organic carbon forms, the largest fraction of the mangrove carbon sink. Below-the-ground components account for only 5% of the total pool while above-the-ground biomass retains five times more (26%) carbon than the root biomass.

Neelagiri stupa, constructed in 2<sup>nd</sup> Century BCE, is a colossal ruined stupa, situated in the woods of the Lahugala Wildlife sanctuary in the Ampara district of the Eastern province Sri Lanka. Presently, one side of the stupa has collapsed and some vertical cracks are visible on the east side of the lower dome. Therefore, it is essential to carry

out a proper investigation on the current condition of the stupa before any major restoration work begins in order to ascertain its total height. With this objective, a series of experimental testing and numerical modeling was performed as described in the paper, *Structural Assessment and Restoration of the Neelagiri Maha Seya in Ampara, Sri Lanka*. According to the Ground Penetration Radar measurements, there exists a gravel type rock layer below the 3m level from the existing ground and the stupa rests on this gravel layer. Laboratory test results showed that ancient bricks of Neelagiri stupa have a higher capacity than their modern counterparts. Numerical analysis of the stupa showed that the stresses generated within the existing stupa due to its self-weight is well below the compressive strength and the tensile strength of the ancient bricks. Finally, a suitable shape is proposed for the restoration and the different restoration options have been analyzed with respect to the structural performance along with the existing conditions.

In addition, this issue includes the 31<sup>st</sup> OUSL General Convocation Address made by Professor Torsten Henry Fransson titled *Challenges and Changes towards a Sustainable Society: Climate, Energy and Education* which reflects on the access to clean, affordable energy and water, and appropriate food, all of which are entangled in humanitarian, social and environmental contexts, and which are the three main pillars of sustainable development. Further, collapses in the quality education will also lead water, food and energy services of the world to a state of stagnation resulting a widespread unfulfilled competition for resources and services among the communities.

We welcome your suggestions for further improvement of this Journal. We are looking forward to publishing your current research findings in our next issue.

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## Protection of Consumer Rights on the Internet: Prospects and Challenges for the Sri Lankan Legal System

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### Abstract

The development of Internet and e-commerce has tremendously changed the habits and behaviors of consumers. This fast and efficient medium of transaction has been able to overcome many obstacles inherent to offline transactions and as a result, e-commerce and e-transactions have become more popular among consumers who are struggling with hectic lifestyles. However, it is evident that online consumers are exposed to many inevitable challenges on the Internet, more than the offline consumers specifically with regard to violation of their consumer rights. Every consumer is entitled to

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several rights whether he/she is dealing online or offline, including the right to information, right to redress, right to privacy, etc. Nonetheless, online consumers are more vulnerable to face the violation of those rights in a virtual market, as they deal with unknown sellers and vendors. Therefore, protecting consumer rights in the online marketplace is a timely important topic. At the international and regional level this issue has been discussed and the OECD Guidelines for consumer protection in E-Commerce, the United Nations Guidelines on Consumer Protection and European Union Directive on Consumer Rights are some of the examples for online consumer protection. Currently, Sri Lanka is in the process of developing information and communication technology, as well as e-commerce. In the recent decades, Sri Lankan legislature has paid attention to introducing new laws to facilitate e-commerce and electronic transactions such as the Electronic Transactions Act and the Computer Crime Act. At the same time, in 2003, Sri Lankan consumer protection legal regime was also repealed. As a result, the Consumer Affairs Authority Act was enacted. However, aforementioned legislations fail to specifically address the issue of protecting online consumer rights. Therefore, the aim of this research is to analyze the existing Sri Lankan legal framework and highlight the lacuna relating to online consumer protection. The research will basically use the qualitative approach and extensive literature analysis will be used for collecting primary and secondary data.

**Key words:** Online consumer protection, e-commerce, electronic transactions, Consumer rights

## **Introduction**

"The Internet challenges the traditional position of consumers" (Prins, 2003).

As the above statement highlights, the Internet has become one of the most influential factors for the traditional position of the consumers in all over the world. The arrival of the Internet has opened many new doors for commercial transactions and as a result, the Internet has had a significantly impact on the nature and behaviours of traditional offline consumers. As Alsagoff (2006) points out "the advancement of technology and globalisation has moved consumers to a different platform of transactions". Thus, it is obvious

that consumers who are engaging with the commercial transactions via online have to face different challenges, other than the traditional consumers.

According to the Guideline 3 of the United Nations Guidelines on Consumer Protection in 2016 (hereinafter referred to as 'UNGCP'), the term 'consumer' is generally referred to as "natural person regardless of nationality, acting primarily for personal, family or household purposes". The rationale behind consumer protection is to make a fair balance between consumer-supplier relationships. Consumers are considered 'weaker' than their contracting partners and due to their inferior bargaining power, they are unable to protect their interests (Ruhl, 2011; Abeysekara, 2013). As mentioned in the UNCTAD Manual on Consumer Protection (2016) consumer protection addresses disparities found in the consumer-supplier relationship, which include bargaining power, knowledge and resources. Furthermore, the Manual highlights that state should intervene to afford consumer protection to assure economic efficiency, protect individual rights and right to development and achieve distributive justice.

In recent decades, global attention was drawn to make separate guidelines and policies for protecting consumer rights on the Internet due to great vulnerabilities which online consumers have to face, other than the offline consumers (El-Gendi, 2017). Information disclosure, online privacy, payment security, online fraud, redress and etc. are some of the problems which online consumers are exposed to when they are engaging in electronic transactions (Sullivan, 2016; Prins, 2003; Waite, 1999). As a result of this vulnerable nature, it is obvious that consumers are somewhat reluctant to engage in and ripe the deserved benefits of online transactions (Lee & Turban, 2001). Therefore, as Prins (2003) aptly argues, "protecting the interests of consumers entering into online transactions is an essential factor in establishing trust in electronic commerce".

At the international and regional level, the problem of online consumer protection has been addressed in a progressive manner. Internationally, Organization of Economic Cooperation and Development (hereinafter referred to as the 'OECD') has introduced comprehensive guidelines for consumer protection in the context of

electronic commerce in 2000. The UNGCP also addresses common issues in Business to Consumer (hereinafter referred to as 'B2C') transactions. In the European Union (Hereinafter referred to as EU) law, the Consumer Rights Directive 2011/83/EU (hereinafter referred to as CRD) is considered as an umbrella legislation of repealing and replacing several consumer-related Directives. (Sullivan, 2016; McClafferty, 2012). Accordingly, the United Kingdom has implemented the CRD by enacting Consumer Rights Act in 2015 and this piece of legislation is considered as "one stop shop of consumer rights" for both online and offline consumers (El-Gendi, 2017).

Though, online consumer protection mechanisms have rapidly developed at international level, neither Sri Lankan consumer protection law, electronic transaction law nor any other legislation has specifically addressed the online consumer rights in Sri Lanka (Kariyawasam, 2008; Abeyrathna, 2008). Therefore, on the one hand, from the consumer rights perspective, Sri Lankan e-consumers are in great danger in the cyberspace (Fernando, 2013). Moreover, as indicated by the Ceylon Chamber of Commerce (2017), the current online sales are just 1 per cent, when compared to the annual consumer sales in Sri Lanka. Accordingly, this research argues that the absence of the proper online consumer protection mechanism has a negative influential factor in online commerce of Sri Lanka. Therefore, this research emphasises that it is necessary to develop an appropriate legal framework for online consumer protection in Sri Lanka. The suggested model would be enriched with a comparative analysis of the EU approach on e-consumer protection, particularly its implementation in United Kingdom (Hereinafter referred to as UK).

## **Research Problem**

Even though e-commerce and electronic transactions have rapidly developed as a global trend all over the world, it is notable that Sri Lankan consumers are still unwilling to place full trust and confidence on online commercial transactions. Online consumers face greater risk in the cyber space when compared to traditional offline consumers, since they are dealing with unknown sellers and vendors. However, the Electronic Transactions Act, No. 19 of 2006, the Consumer Affairs Authority Act, No. 9 of 2003 or any other legislation in Sri Lanka, do not address any specific issues faced by online consumers. Therefore, in addition to the lack of computer

literacy and other reasons related to infrastructure, the absence of proper e-consumer protection law can be identified as the key factors which could reduce the willingness of the consumers' to engaged in online transactions. Nevertheless, it is obvious that, as a developing country, Sri Lanka needs to gain the trust of e-consumers to attract more investments and engage with the global market. Therefore, the research problem focuses on how to develop an appropriate legal framework for online consumer protection to enhance the consumers' trust and confidence in electronic transactions in Sri Lanka.

## **Methodology**

As mentioned above, the main objective of this research is to propose a new legal framework for online consumer protection in Sri Lanka. In order to achieve this, the researcher has selected the qualitative research approach as the main research methodology. Dobinson and Johns (2007) point out that a qualitative legal research could be a doctrinal, theoretical, problem, policy or law reform research. Accordingly, this research is a reform-oriented legal research.

Moreover, this research is a comparative study between Sri Lankan and other two selected jurisdictions. The main research area of the research; namely, 'online consumer protection' is a novel concept for the Sri Lankan legal system. Therefore, in order to develop an effective legal framework for Sri Lanka, the researcher has to compare and contrast the existing Sri Lankan law with the other jurisdictions which have already been developed as an advanced mechanism to protect consumer rights in the online marketplace. As mentioned earlier, the EU has enacted a separate Directive for protecting consumer rights in the EU countries and it is able to provide more advanced protection for offline as well as online consumers. Subsequently, the UK Parliament has enacted The Consumer Right Act (hereinafter referred to as 'CRA') in 2015, implementing the key features of the CRD. El-Gendi (2017) defines the CRA as a "one stop shop" because it has combined many previous Acts and regulations to assure stronger consumer protection in both the online and offline context. Based on these developments the researcher has selected the EU and UK jurisdictions as the main legal paradigms for the comparative analysis. Both primary and secondary sources are used

to gather data with regard to existing Sri Lankan legal framework and comparative jurisdictions. As primary legal sources, Sri Lankan legislation such as the Electronic Transactions Act, No. 19 of 2006, Consumer Affairs Authority Act, No. 9 of 2003, Computer Crime Act, No. 24 of 2007 etc., emerging case law jurisprudence and international and regional legal instruments are examined. Journal articles, research papers and reports are studied as secondary legal sources.

## **Theoretical Framework**

Consumer protection is generally justified by considering consumers as weaker than their contracting partners. Therefore, it is accepted that their interests should be protected due to inferior bargaining power. The doctrine of 'inequality of bargaining power' stresses the economically weaker position of the consumer *vis-a-vis* the suppliers (Haupt, 2003). As Barnhizer (2005) points out from the United States case law, "gross inequality of bargaining power could negate the meaningfulness of choices available to the weaker party".

The 'exploitation theory' also provides a similar view to the 'weaker party' argument. According to this theory, consumers are in need of protection for two reasons: first, consumers have few options but to purchase and contract on the terms set by increasingly large and powerful companies; second, companies are able to exploit significant information and sophistication disparities in their favour (Ruhl, 2011).

However, at least several scholars are of the opinion that this traditional theoretical argument on identifying the consumer as the weaker party is no longer valid in the modern context. As Ruhl (2011) argues, "exploitation theory fails to take into account competition between companies and the fact that any bargaining power that companies have *vis-a-vis* consumer is limited through competition from other companies". Therefore, the author suggests that economic theory is the best theoretical rationale for consumer protection today, because consumers should be protected from the information asymmetry between them and the professionals.

The 'economic theory' of law is mainly concerned with promotion of economic efficiency and the protection of wealth as a value. According to the Posner, a leading scholar of the Chicago School of economic analysis, contractual transactions are the fundamental mechanisms

for wealth maximization (Mc Coubrey & White, 1999). As Posner further highlights, “contract law has had to change a great deal since then to cope with modern consumer transactions where there is no delay between agreement and performance” (Mc Coubrey & White, 1999). Therefore, the economic theory justifies the movements of goods and services through electronic transactions, because the flexibilities and opportunities of online markets are larger than the space of face-to-face transactions. Therefore, it can be argued that a strong consumer protection mechanism can be an incentive to develop trustworthiness and confidence on the electronic transaction. Based on that argument, the incentive theory can be applied to justify consumer protection in electronic transactions as well.

Moreover, the concept of trust can be used as another theoretical background for this research. From the behavioural economists’ perspective, “trust has long been regarded as a catalyst for buyer-seller transactions that can provide consumers with high expectations of satisfying exchange relationships”. (Pavlou, 2003). Therefore, Pavlou (2003) argues that the role of trust is of fundamental importance for adequately capturing consumer behaviour in e-commerce. O’Hara (2005) also supports this view by developing an argument which explains the relationship between the law and trust, called “safety net assessment”. Accordingly, the law can play a major role to create trust between two parties. Therefore, to the extent that the law works towards decreasing the vulnerability of a contractual relationship, it promotes the parties willingness to enter into a contractual obligation (O’Hara, 2005).

Thus, the aforementioned theoretical approaches are the foundation for this research. The doctrine of inferior bargaining power, exploitation theory and the economic theory provide the theoretical rationale for consumer protection. The economic theory also justifies the electronic transactions and e-commerce activities as tools for wealth maximization. In addition, the trust theory based on behavioural economic conception, builds up the link between the law and consumer trust and thereby increases confidence in online market.

## **Results and Discussions**

### **Benefits, Key Legal Issues and Challenges Faced by Online Consumers**

“The Internet is becoming an increasingly popular means for the sale of goods and more and more transactions are being made online...The increase in online transactions raises the issue of whether or not there is sufficient protection for the e-consumer. Due to the risks inherent in online transactions there is a need for these types of transactions to be specifically acknowledged and regulated” (McClafferty, 2012)

As McClafferty (2012) aptly highlights in the above statement, even though online transactions are becoming more popular, they raise several issues due to the risk inherent to such transactions. Waite (1999) also brings a similar view and opines that “Internet could bring about radical change in distance selling by providing instantaneous, low-cost links for marketing and payment between consumers and suppliers world-wide; that there are resultant risks as well as benefits.”

When examining the positive factors of the online transactions from the consumers' perspective, it is evident that during the last few decades consumer attractions to e-commerce and online transactions have increased rapidly due to their flexible nature. Looking and comparing goods and products are easier on the Internet than the offline market (Khan, 2016). Therefore, consumers have more opportunities for selection and also enjoy easier access to information. , Moreover, Khan highlights that consumers can save their time by just clicking a button on the Internet from home or work place (Khan, 2016). Thus, some scholars such as Edward (2003) and Prins (2003) argue that online transaction and e-commerce have improved the 'consumer sovereignty' and they regarded it as a positive force for consumer empowerment.

However, it is observed that although online consumers are enjoying significant benefits in the online marketplace, they have to face considerable amounts of risk and vulnerabilities during their transactions such as information disclosure, violations of privacy, lack of systems security, dispute resolution, etc. These issues would negatively impact consumer trust and confidence on e-commerce.

Particularly, in the developing countries, due to technology barriers and other infrastructure problems, consumers express more hesitancy to engage with electronic transactions. Therefore, as mentioned by the UNCTAD, “an adequate and supportive legal environment is essential to create trust online and to secure electronic interaction between enterprises and consumers” (UNCTAD Manual, 2016).

### **International and European Union Approaches on Online Consumer Protection**

At the international level, the OECD has introduced separate guidelines for online consumer protection, namely, the Guidelines for Consumer Protection in the Context of Electronic Commerce, 1999. As Alsagoff (2006) indicates the OECD guidelines “act as platform for its member countries to develop their national law in tandem with the international standards” (p.82). The principle 1 of the OECD Guidelines highlights that,

Consumers who participate in electronic commerce should be afforded transparent and effective consumer protection that is not less than the level of protection afforded in other forms of commerce

The United Nation Guidelines on Consumer Protection (hereinafter referred to as UNGCP) is the most recent major international step towards consumer protection. As Yu & Galligan (2015) point out, the UNGCP provides an advanced global standard on consumer protection for the purpose of delivering justice to every individual consumer. This opinion is very much highlighted in the objectives of the UNGCP. Accordingly, the main objectives of the UNGCP are “to assist countries in achieving or maintaining adequate protection for their population as consumers, to facilitate production and distribution patterns responsive to the needs and desires of consumers, to encourage high levels of ethical conduct for those engaged in the production and distribution of goods and services to consumers”.

Among the regional mechanisms the European Union’s approach to online consumer protection is significant. According to the Finocchiaro (2003), the main objective of the European e-commerce legislations is to promote e-commerce. Therefore, he argues that

consumer protection in electronic transaction is an indispensable factor from this economic objective. The Consumer Right Directive (CRD) is the recent development of the EU law, which was enacted in 2011 and replaced in 2014. The CRD is considered as an umbrella legislation of repealing and replacing Distance Selling Directive, Doorstop Selling Directive, Unfair Terms in Contracts Directive and the Sale of Consumer Goods and Associated Guarantees (Sullivan, 2016; Mc Clafferty, 2012).

As Article 1 of the CRD indicates, the purposes of the Directive is the achievement of a high level of consumer protection, to contribute to the proper functioning of the internal market. Article 5 and 6 of the CRD provide the information requirement for both contracts other than the distance and off premises contracts. Accordingly, before a consumer is bound by a contract, the trader should provide relevant information such as main characteristic of the goods, identification of the trader, geographical address, and the price of goods in a clear and comprehensive manner.

As Sullivan (2016) opines, the rationale for this information requirement is an attempt to address the inherent information imbalance that exists between consumer and trader who has more knowledge of the market. Therefore, it can be argued that the information provisions of the CRD are a tool to enhance the consumer confidence in the Internet market.

Notably, another new feature of the CRD is the extension of the cooling-off period of a distance contract from seven to fourteen days. Article 9 of the CRD states that consumer should have a period of 14 days to withdraw from a distance or off-premises contract, without giving any reason, and without incurring any costs. As Sullivan (2016) comments, “this extended period from seven to fourteen days was to increase legal certainty and reduce compliance cost for businesses dealing cross broader”

The most attractive feature of the CRD is its potential to cover contacts for the supply of digital contents. According to the Recital 19 of the Directive, “digital content means data which are produced and supplied in digital form, such as computer programs, applications, games, music, videos or texts, irrespective of whether they are accessed through downloading or streaming, from a tangible medium or through any other means”. Moreover, Recital 19, in connection with Article 6 (1) (2), imposes additional information

obligations and requirements on the e-tailors who supply digital content. In particular, these obligations include information on the functionality and the relevant interoperability of digital content (Bezakova, 2013). Therefore, it can be argued that this pre-requirement of information with regard to the digital content makes the consumer more knowledgeable about the goods and services.

Accordingly, it is evident that the OECD Recommendations for Consumer Protection in E-Commerce and the UNGCP provide a comprehensive guidance for member states to adopt and enable consumer protection for online users. Similarly, the EU approach on e-consumer protection is a more solid and broad approach and it can be argued that the EU law has expanded its protection beyond the international legal framework. In 2015 the UK parliament enacted the CRA by implementing the aforementioned key features of the CRD.

### **Online Consumer Protection in Sri Lanka**

During the last few decades, the Sri Lankan E-commerce sector has experienced rapid development. More recently, scholars have paid attention to the study of influential factors for e-commerce growth and its impact on the market economy in Sri Lanka. Arawwawala & Gunawardane (2017) analysed the challenges and barriers of implementing e-commerce among SMEs in Sri Lanka. In this research they have identified that confidentiality issues, privacy of the data, security issues in making the payments in online etc. as some of the challenges which inhibit the e-commerce developments in Sri Lanka. In addition, Kapurubandara (2009) in another research also highlights e-commerce adoption barriers in Sri Lanka such as lack of computer literacy, poor Internet facilities, lack of governmental support, fears and concerns over security. Peris & Kulkarni (2015) also support this view and reveal that one reason for consumer reluctance is their concern about security risks, particularly with regard to the increasing number of security vulnerabilities and poor security measures to protect personal information.

As O'Hara (2005) denotes, "to the extent that the law works towards to decrease the vulnerability of a contractual relationship, it also promotes the parties willingness to enter into a contractual obligation". Therefore, it can be argued that although the

aforementioned issues related to infrastructure and other reasons negatively influence the e-commerce growth in Sri Lanka; the absence of proper e-consumer protection law is one of the key factors which leads to the reduction of the willingness of consumers to engage with online transactions. In order to explore more on this argument, it is important to analyze the existing legal framework in Sri Lanka.

## **Existing Sri Lankan Legal Framework**

Sri Lankan legislature stepped into electronic transaction law in 2006 by enacting the Electronic Transactions Act, No. 19 of 2006 (hereinafter referred to as 'ETA'). Since then the Computer Crime Act, No. 24 (hereinafter referred to as 'CCA') was introduced in 2007, in order to strengthen the legal framework. Consumer protection law of the country was also repealed in 2003 by enacting Consumer Affairs Authority Act, No.9 of 2003 (hereinafter referred to as 'CAAA'). This Act brought more modifications to the traditional consumer protection law but, failed to address the consumer protection in online environments.

The ETA was introduced as a significant piece of legislation which broadly addresses the issues in electronic transactions in the country. The Act closely follows the UNCITRAL Model Law on e-commerce and electronic signatures (Kariyawasam, 2008). However, when examining the consumer protection mechanism under the ETA, any direct provision regarding online consumer protection is hardly found. Conversely, it can be argued that the recognition of electronic records, electronic signature and admissibility of electronic evidence may impliedly provide protection for online consumers. Nevertheless, Kariyawasam (2008) makes propound argument that:

“[T]he Electronic Transaction Act is silent about online consumer protection in relation to, for example, information disclosure, delivery, transaction confirmation, cancellation and refund policy”

According to the Kariyawasam's argument, it is evident that the ETA does not expressly deals with the online consumer protection issues. Moreover, the ETA fails to provide adequate data protection mechanism which can secure consumer privacy in the cyberspace.

The CCA was enacted in 2007 to provide identification for computer crimes and to provide the procedures for the investigation and

prevention of such crimes. The CCA covers a broad range of computer crimes such as computer hacking, computer cracking, unauthorized modifications, illegal interception and etc. The CCA is important in online consumer protection, due to Section 10 of the Act. The Section 10 of the CCA recognizes unauthorized disclosure of information as a computer crime. Section 10 provides that,

“Any person who, being entrusted with information which enables him to access any service provided by means of a computer, discloses such information without any express authority to do so or in breach of any contract expressed or implied, shall be guilty of an offence and shall on conviction be liable to a fine not less than one hundred thousand rupees and not exceeding three hundred thousand rupees or to imprisonment of either description for a term not less than six months and not exceeding three years or to both such fine and imprisonment.”

This provision affords some basic protection for online privacy issues. However, as Fernando opines, still there is a gap in the Sri Lankan data protection law (Fernando, 2013). Moreover, it can be argued that, though the CCA provide protection for unauthorized information disclosure in online transactions, that single provision cannot address other complicated issues faced by online consumers such as payment security, online fraud, and dispute settlement.

The Consumer Affairs Authority Act (CAAA) provides general protection for consumers and traders by establishing the Consumer Affairs Authority in Sri Lanka. The main objectives of the establishment of the Authority are to promote effective competition and the protection of consumers as well as to regulate internal trade. As Rodrigo (2013) correctly spells out, “the introduction of the CAAA as the key consumer legislation marks a significant legislative development in the area of consumer protection”.

According to the Part II of the CAAA, the Consumer Affairs Authority has powers to regulate trade by undertaking studies on the distribution of goods and services, issuing directions to manufacturers and traders, determining standards and specifications relating to goods and services. However, the Act does

not confer any specific authority to regulate online trade and services and most importantly the Act does not deal with some of the major consumer remedies, particularly for granting cooling-off periods (See: Rodrigo, 2013).

Conversely, it can be argued that, although the CAAA is silent about the online consumer, the same provisions in the Act can be applied to online consumers as well. According to the interpretation section of the Act, the term 'service' includes "the provision of the Information Technology and Communications". Therefore, can this interpretation be considered as an adequate initiative for online consumer protection? It is obvious that the complex nature of the online transactions requires more solid protection, particularly when addressing the online consumer protection.

Therefore, it is notable that, as well as the aforementioned electronic transaction legislations in Sri Lanka, the CAAA has also failed to provide a mechanism for protecting the online consumer rights. Recently, the Consumer Affairs Authority (CAA) and the Information Communication Technology Agency (ICTA) collectively discussed the importance of 'consumer protection in the 'digital age' in order to facilitate policy recommendation for online consumer protection. In this forum Weragoda (2017) has criticized the CPAA for not offering adequate dispute resolution mechanism/s in the current digital era.

Accordingly, it can be reasonably argued that the existing IT law regime or the consumer protection legal regime in Sri Lanka does not adequately address the issues of online consumers.

## **Conclusion**

“Electronic transactions are of growing importance to Governments, enterprises and consumers in most parts of the world. While greater reliance on electronic commerce creates significant opportunities, a lack of security and trust remains a critical barrier to such transactions.” (UNCTAD Secretariat, 2015;)

As this statement indicates, today a country cannot go forward without embracing the advancement of technology. The e-commerce sector of Sri Lanka is ready to grow in the next few decades. However, the lack of proper consumer protection mechanism in an online

environment creates a stumbling block to the growth of e-commerce. Therefore, as a developing country, it is necessary to take relevant steps to remove this barrier from the e-commerce sector in Sri Lanka.

The international and regional developments demonstrate how those barriers could be overcome by enacting strong consumer protection mechanisms for online consumers. Particularly, the EU and UK examples emphasize some progressive mechanisms to regulate online consumer transactions such as information requirement, extension of the cooling-off period, privacy protection, contracts relating to digital contents etc. When comparing the Sri Lankan situation with those advanced mechanisms, it is evident that either Sri Lankan IT law or consumer law does not adequately provide a consumer protection legal framework for online commercial transactions. This research attempts to highlight this gap and further emphasizes the need for an adequate online consumer protection mechanism embedded into the Sri Lankan legal landscape.

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## Flaws in Research Report Writing: An Evaluation of Research Reports Submitted for an International Conference on Education

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### Abstract

The present study was undertaken to assess papers presented during the 5<sup>th</sup> International Conference organized by the Collaboration of Education Faculties in West Africa (CEFWA). This was done with a view to revealing participants' deficiencies in research report writing. The sample for the study comprised of 65 research reports submitted for peer review process by the conference participants. Data sources include reviewers' assessment of research report using the CEFWA Research Report Rating Scale (C3Rs-a five Likert scale) and reviewers' comments and suggestions on the weaknesses and strengths of the research reports. Based on these data sources, both descriptive statistics (e.g., mean) and content analysis of reviewers' evaluation comments were used in the data analysis. The results of the study

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revealed that (1) the journal-conference proceedings rejection rate was 47.7% (2) the Introduction and Discussion were rated as weak; Literature Review, Methodology, Results and Conclusion were rated as fairly good; the titles and abstracts of submitted research reports were rated as good. Furthermore, the study revealed the following as the primary flaws associated with the Introduction, Literature Review, Methodology, Results and Discussion sections of the research reports: (1) improper focus on the study objectives and non-indication of gaps in knowledge (2) lack of attempt to critically critique the methods(s) used in previous studies (3) inadequate description of research designs (4) non-self-explanatory of tables and figures and (5) lack of discussion about the significance and implications of results. Based on the findings of this study, it was recommended that concerted efforts should be made by education faculties to organize faculty seminars where research report can be presented for constructive criticism. Also, universities and research institutions should endeavor to reward researchers for quality rather than quantity of their publications.

**Key words:** research reports, peer review process, journal rejection rate, editorial decision, journal editor

## **Introduction**

In today's world, higher institutions of learning are established purposely to engage in teaching, carry out research and render services to the community. In fulfilling their responsibilities as researchers, specialists in different areas of study in the university community conduct research for various reasons. According to Moher&Srivastava (2015), researches are conducted by the academic staff in higher institutions of learning for three main purposes: to share their findings with colleagues in the same field and others outside their areas of specialization, to influence current practices and/or policy within a specific discipline and to get their papers published in order to withstand the pressure of publish or perish slogan. This is because survival of lecturers in the universities and other tertiary institutions depends on the total number of publications they possess in reputable journals. Universities nowadays use a lecturer's authorship of printed referred research report as one of the major promotion criteria and standard (Bordage & Caelleigh, 2001; Holliday, 2007).

The importance attached to publications in promoting lecturers accounted for fraudulent practices in which low quality research reports get their way into the journals (Kallestinova, 2011). Realizing the fact that publication is a major factor for getting promotion and

receiving annual increment in salary, academic staff struggle to have both offshore and onshore publications. It has been observed that in some Nigerian universities the ratio of offshore to onshore publications is also taken into consideration during annual review of lecturers either for promotion or annual salary increment (Ahupa, 2014). In getting their research reports published, lecturers encountered some hindrances. As reported by Kleinert & Horton, (2014), barriers to publication include: potential journals' unwillingness to publish the content considered to be inappropriate and very high journal rejection rates particularly in "luxury" journals. For instance, reputable journals such as *Science Education*, *International Journal of Science Education*, *Journal of Research in Science Teaching*, *Chemistry Education Research and Practice*, *the American Biology Teacher*, and *the American Physics Teacher* are few examples of journals in the field of science education with high rejection rates. In a bid to overcome these obstacles, various means have been adopted by desperate lecturers to get their papers published as publication is a major criterion for promotion. It is unfortunate that these lecturers are being assisted in fulfilling their intention by some so called professional associations that are floating journals with low rejection rate in an attempt to attract prospective authors to publish in their journals.

Many conferences are being organized by these 'predatory' associations both within and outside Nigeria with the intention of getting the lecturers' research reports published (Ahupa, 2014). This term, predatory, was first coined by librarian Jeffrey Beall at the University of Colorado, Denver, USA having observed its prevalence (Butler, 2013). The term was used by him to describe publishers who engaged in the practice of publishing of research reports without the necessary quality controls, such as appropriate peer review and professional copy editing to ensure high-quality research. Regrettably, both inexperienced academics (who are unaware or eager for rapid promotion) and experienced academics (who intend to pad their curriculum vitae) patronize these questionable conferences (Wager, 2017). The issue of 'predatory' conferences is not peculiar to Nigeria. It is a global issue which is a serious concern to academics in different countries of the world (de Jager et al., 2017). Nowadays, many institutions have taken measures to prevent academics from falling prey to such events by carefully scrutinizing conference details before releasing university funds or grants for any international conferences.

These predatory associations went as far as adopting a strategy of repeatedly sending electronic mails inviting prospective authors to submit research reports for publication without any proper peer

review process. Unsolicited and unwanted (spam) electronic invitations to speak at or attend conferences, or write for, or edit journals are a burgeoning aspect of academic life. However, there exist many recognized professional associations that organize conferences on contemporary issues on education. Unfortunately, they receive low patronage from the lecturers on the ground that their research reports of inferior quality might be rejected by these associations.

Although a plethora of research and literature (e.g., Girden&Kabacoff, 2010; Rhodes, 2011; Pautasso, 2013) in education has attempted to ensure that there is quality in paper published in university based and associational journals, further studies are still needed in this direction. It should be noted that research focusing on peer review process as a means of harvesting quality research reports for publication in journals are still missing in the literature. Majority of the publications focused on describing peer review process, highlighting guidelines for reviewing research reports for educational journals and discussing essential qualities of editors and reviewers. Therefore, the present study aims at filling the existing gap in literature by assessing research reports presented and submitted during an international conference on education organized by the Collaboration of Education Faculties in West Africa (CEFWA). This is done with a view to identifying flaws in research reports writing submitted by the conference participants for peer review process. Only research reports that were presented during the plenary sessions and subsequently submitted by the authors for publication are subjected to peer review process by the editorial board. These research reports are either published in the refereed conference proceeding or the CEFWA journal based on the editorial decision regarding the research reports' quality. In some cases, conference participants may present research reports at the plenary sessions and decide to publish them elsewhere. Contrary to the best and common practice, CEFWA refereed conference proceedings are published alongside with the peer review journals after the conference. Both publications are subjected to the peer review process. Only the book of abstracts of conference papers is made available and the copies of the book are distributed to conference participants.

In this study, the guiding research questions are:

- (1) What is the acceptance rate of research reports submitted for peer-review during 2014 CEFWA conference?
- (2) How do the reviewers rate the various sections of the research reports submitted for peer-review?
- (3) What are the common flaws in the research reports identified by the reviewers?

## **Literature Review**

The main objective of any research report is to properly communicate the author's findings to the readers (Wallieman, 2001). Writing a quality research report requires possession of good writing skills. The required writing skills are distinct and must be practiced in order to be fully competent in its discourse patterns. (Loseke & Cahill, 2004). Unfortunately, for most undergraduate students, research report writing skills are not satisfactorily taught (Showman et al., 2013). Inexperienced researchers tend to encounter problems in writing quality research reports (Wicherts, 2016). Different types of pitfalls are associated with different sections of research reports (Ali, 2010; Kowalczyk et al., 2015).

The research reports are organized in such a way that the information flow from general to specific and then back to general. The Introduction presents the problem and provides general information while the Literature Review provides a critical appraisal of the previous studies related to research area under focus rather than a simple summary of prior studies. The Methodology provides the information by which a study's validity is judged while the Result section states the findings of the research arranged in a logical sequence. Section titled Discussion/Conclusion discusses the findings in a larger context. The following section describes each of these sections and their associated pitfalls in details.

Preceding the Introduction section are the Title and the Abstract. The title reflects the content of the research report. According to Peat, Mellis, Williams&Xuan (2002), an effective title should possess the following characteristics: (1) identify the main issue of the paper (2) begin with the subject of the paper (3) is accurate, unambiguous, specific and complete, and (4) attract readers. Among the notable pitfalls commonly found in this section of a research report are: the title inadequately describes the article and the inclusion of unclear abbreviation and jargon in the title (Swales & Christine, 2009).

An abstract is a concise, one-paragraph summary of the whole paper. Its length varies but seldom exceeds 200 words. A good abstract is expected to provide a complete synopsis of research objectives addressed, methods employed in proffering a solution to the problem, result obtained, conclusion drawn and implications of findings. Major errors commonly associated with an abstract are: (1) dissonance between the information in the abstracts and the information in the full text, (2) abstract exceeding maximum number of words allowed (Perneger & Hudelson, 2004).

The Introduction section is set aside for describing the nature of problem to be addressed and explaining why the study is of interest. As viewed by the American Chemical Society (2006), a well-written Introduction in any research report is a clear statement of the problem and the rationale for embarking on the specific study. A good Introduction is expected to fulfill the following purposes as specified by Biggam (2011): (1) provide preliminary background information to place the present study in context (2) clarify the focus of the study (3) specify the overall research objective (4) specify what has been done, what has not been done and what still needs to be done. When the Introduction of a research report fails to describe the purpose and objective of the study and in addition, contains materials irrelevant to the study or belonging to other sections of the research report, then such an Introduction can be assessed to be deficient (Gupta, 2017).

The Literature Review section situates an existing literature in a broader scholarly and historical context. The purpose of a Literature Review is to describe past important research and relate it specifically to the research problem. This section includes all relevant findings from two credible sources which are the conceptual literature and the research literature. Significant pitfalls usually associated with this section is reflected in the inability of the research report writer to (1) compare and contrast findings from different studies (2) compare and contrast methodologies used to arrive at those findings (3) critique the methodologies, noting important strengths and weaknesses and (4) suggest extension of the studies (Weber et al., 2002). Similarly, Lee et al. (2013) observed that emerging researchers when writing a Literature Review simply report previous research results without relating them to the current findings.

The Methodology section typically features a description of the population and sample that were involved, the study design, and the instrument used, the data collection procedure and the data analysis technique. The Methodology section is the most important aspect of a research paper because it provides the information by which the validity of a study is ultimately judged (Shattell et al., 2010). Therefore, the researcher must present this section in such a way that these two important questions are properly addressed: (1) how were the data collected or generated? (2) how were they analyzed? The most commonly found errors associated with this section are poor reporting of statistical methods and inadequate description of data collection procedure thereby preventing replication of the study (Shea ., 2001; Fox et al., 2016).

The Results section is specifically designed for the presentation of tabular or graphic summary of research findings, listed under headings in accordance with the formulated research question. For many authors, writing the Results section is more intimidating than

writing the Methodology (Gallo et al., 2014). The results of the study carried out should be presented in a consistent manner to the reader. In presenting results visually, Kallestinova (2011) offered the following guidelines: (1) graph and tables should be used to reveal trends in the data, but they must be explained and referred to in adjacent accompanying text and (2) figure and tables should be used to summarize, amplify or complement information already given in the text. In a bid to advise postgraduate students, Murray & Hughes (2008) highlighted some common errors to be avoided such as incomplete and/selective reporting of findings, presenting reports from different studies and illogical presentation of findings.

The Discussion section is conceived as the counterpart to the introduction since this part should lead the reader from narrow and very specific results to more general conclusions (Lovejoy et al., 2011). It is often the most difficult section of research report to write. A well-written discussion section includes a statement of important results, reference to previously published and relevant literature, comparison of study results with previously reported findings, explanation of result, elucidation of strengths and weaknesses of the study and description of impact of the study.

The Conclusion section introduces the work, briefly states the major results and the major points of the discussion. This aspect finally ends with a statement of how the present research contributes to the overall field of study. As advised by Young (2003), authors of research reports should guard against the following mistakes when discussing findings (1) failure to locate present results in the context of finding from other studies (2) overstating the implications of the results and (3) failure to describe the limitation of the study.

The Reference section typically features an alphabetical list of the sources consulted during the conduct of the study. Each reference related to a journal is expected to reflect the names(s) of author(s), title of the paper, journal name, volume number of the issue in which the article appeared, starting page number, end page number and year of publication. In the case of a book, its author(s), title, publisher's name, place of publication, year of publication and edition are expected to be given. Some common pitfalls associated with this section are: (1) omission of some references that have been cited in the text. (2) references are out of date or cannot be accessed by most readers (Derntl,2014).

Despite the fact that certain sections of research report are difficult to write, academics are required to publish quality work in reputed journals. This is because the development and progress in any

profession, including teaching is strongly influenced by publications in academic journals. As observed by Balster (2017) and Christenbery (2011), publication in academic journals has two main advantages. First, it provides professionals with an opportunity to share their research-based practices and research result with colleagues in the discipline. Second, academic publications serve as a source of knowledge for students, novice teachers and emerging researchers. Such benefits can only be derived from quality research reports. To this end, appropriate scrutiny of research reports submitted to academic journals to ascertain their worth, methodological rigour and utility before appearing in the print media and online publications is very essential. In order to ensure that reliable and quality research reports are published in academic journal, most journals put in place peer review process (Bordage, 2001; Ghahramani, & Mehrabani, 2013).

The peer review process has long been the mechanism of ensuring high quality research in academia (Lee, Sugimoto, Zhang & Cronin, 2013). It is the process by which expert's advice editors on the value of research reports submitted for publication (Smith, 2006). Reviewing is more than just grading; it is a means of improving the quality of research report (Fox, Burns& Meyer, 2016). As advised by Hames (2007), it is unethical for a reviewer to allow a seriously flawed research report to escape unchallenged into the peer reviewed journal, where it will be a trap to the emerging researchers and students who will read the research report superficially and will simply accept flawed conclusion at face value.

### **An overview of the CEFWA peer review process**

The peer review process varies slightly from journal to journal. CEFWA uses a peer review process (Fig. 1) essentially as a quality control mechanism. Research reports featured in the CEFWA publications are obtained only through yearly organized conferences. For a research report to be published in the CEFWA journal or refereed conference proceedings, the usual procedure for an author is to submit a copy of the research report to the conference's Local Organizing Committee (LOC) after presentation at the plenary session. If, after an initial superficial screening by the journal editor, the research report appears to be appropriate to the journal's aims and scope, the editor will send it to two reviewers. These reviewers are very often faculty members at universities who are known to be knowledgeable in the area pertaining to the research report. These reviewers provide the editor with a written evaluation of the research report along with their recommendations as to whether or not the editor should publish the article. It is quite common for these

reviewers to suggest possible modifications of the research report in order to meet the standards for publication. The editor must then send the reviewers' comments and suggestions with an editorial decision to the author. If the research report receives a totally good evaluation from the reviewers, it will very likely be published in either journal or refereed conference proceedings (perhaps after some revisions).

Categorization of accepted research reports into those to be featured either in the CEFWA journal or conference proceedings is based on the quality of the research report as judged by editorial advisory board using the criteria such as originality (40%), relevance (30%), timeliness (15%) and critical pertinent problem addressed (15%). Based on these criteria, only research reports with assessment score of 60% and above are eligible to feature in the CEFWA journal. If the editor receives mixed reviews, the author might be asked to do a major revision of the research report and to resubmit it for publication. Sometimes, if the reviews are very poor, or if the periodical has too many submitted research reports or if the editor does not feel the article fits in with editorial policy, the author is informed that the article has been rejected. However, in a situation where research reports were rejected on the ground of space limitation, authors are advised by the CEFWA editor to submit the rejected research reports to another journal within the CEFWA member faculties.

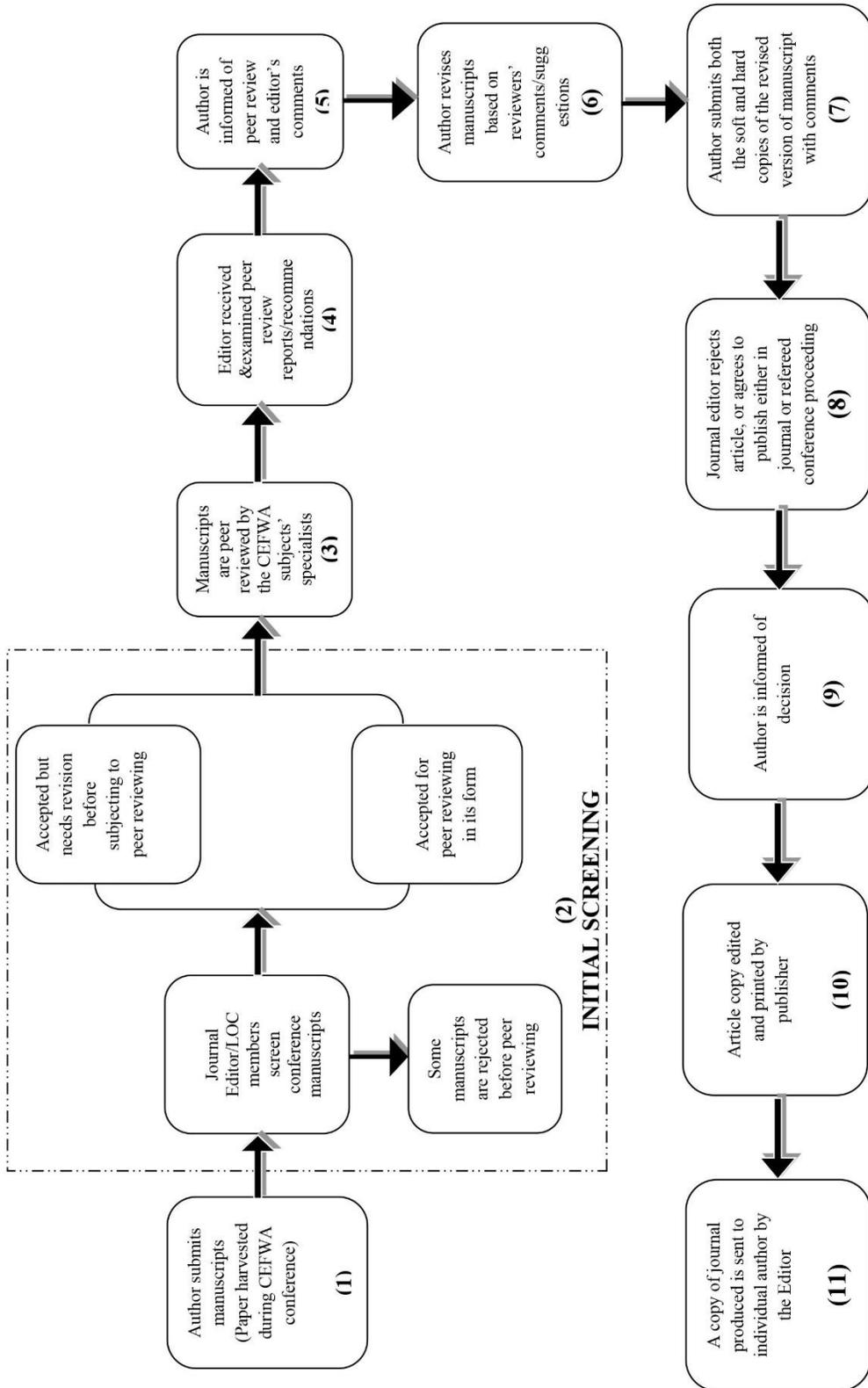


Figure 1. CEFWA Peer Review process for journal publication

## **Methodology**

A mixed methods research design is adopted in this study as the study involves collecting, analyzing and interpreting both quantitative and qualitative data that are essential in addressing the research questions. It was conducted in the month of September, 2014 during the 5<sup>th</sup> International Conference on *Education: Innovation, Policy Implementation and Challenges* organized by the CEFWA. The total number of the registered participants for the conference was 246 (n=246) and was far greater than the number of the research reports presented (n=108) during the conference. Some participants numbering 138 attended without presenting any research report. Out of the presenters (n=108), 43 decided to publish the research reports elsewhere and only 65 submitted their research reports for the peer review. Hence, the study sample consisted of all the research reports submitted by the conference participants for the peer-review process totaling 65 (n=65).

The CEFWA Research Report Reviewers' Evaluation Form (C3RsEF) was used as the main data collection instrument to collect data from the submitted research reports. It comprised two sections (A and B). Section A, the CEFWA Research Report Rating Scale (C3Rs), is a five point-Likert scale consisting of 35 items attached to a scale ranging from, 'very good' to 'very weak' with 'fairly good' as the pivotal of the scale. It was designed to collect information regarding the quality of various sections of the research reports as assessed by the reviewers. Section B demands open responses relating to the reviewers' general comments and suggestions for improvement on the various sections of the papers submitted.

Section A of the C3RsEF had eight sections with a total number of 35 items. These sections are: Title (2 items), Abstract (2 items), Introduction (10 items), Review of related Literature (2 items), Methodology (3 items), Results and Interpretations (3 items), Discussion (4 items), Conclusion and Implication (4 items). The remaining items deal with research report layout guidelines based on the CEFWA journal policy for research reports preparation. These items are criteria developed to guide the reviewers' comments and assessments regarding the research reports' reliability, originality, relevance, appropriateness of the data analysis technique, suitability of the data collection procedure and appropriateness to the journal's aims and scope. Before its adoption by the CEFWA, it was validated by a five-member panel of experts (author, reviewer, editor, publisher and funding agency) constituted by the CEFWA editorial board. In addition, the scale has a satisfactory and acceptable Cronbach's alpha reliability coefficient of 0.86.

The needed data from the submitted research reports were obtained through reviewer's rating of quality of participant research reports using the following scale: very good (4), quite good (3) fairly good/average (2), quite weak (1), very weak (0). On this scale, quite good and fairly good could be interpreted as 'good' and 'mediocre' respectively. Initially, 53 assessors were purposively selected by the Local Organizing Committee (LOC) from 12 Faculties of Education to assess the quality of research reports submitted. Their selection was based on the criteria specified by Murray & Hughes (2008), and Balster (2017): (1) they are knowledgeable about a specific field of study (2) they possess specialized knowledge of the potential advantages and pitfalls of various research approaches and are capable of reviewing within time frame and writing constructive comments on the research reports received. Finally, 48 reviewers were selected by the editor taking into consideration the reviewers' experience and reputation, and evidence of having published on the same topic to be assessed. Reviewers were not randomly selected from the initial pool of reviewers in order to avoid a situation whereby a research report would be judged by those who are less capable. Being an active member of the Local Organizing Committee (LOC), gave the researcher great opportunity of having access to the data used in this study.

The data collected from the rating scale were analyzed using a descriptive statistic in form of mean (quantitative) while the non-numerical data (Section B of the CEFWA Research Report Reviewers' Evaluation Form) reviewers' comments on different aspects of research reports) were analyzed using contents analysis. This type of analysis is used when a researcher wants to analyze a written or spoken record for the occurrence of specific categories of events, items or behavior. Hence, its usage is relevant in this study. Prior to the actual content analysis process, two coders (two experienced reviewers) independently coded samples of reviewers' comments retrieved from the CEFWA archive, compared categories, and resolved differences via discussion. This preliminary coding exercise was done with a view to prepare the coders for the actual content analysis. Thereafter, the currently harvested reviewers' comments were read and re-read by the two coders in order to gain deep understanding of the reviewers' comments. Based on the coders' understanding of the ideas expressed by the reviewers', flaws reported by the reviewers were assigned to categories which correspond to different sections of a research report. The coding performed by the coders largely coincided, but little variations in coding were discussed and adjusted. The results of reliability test showed an acceptable level of inter-rater agreement of 82% (concordance) between the two coders. In order to ensure confidentiality in reporting the findings, the reviewers' comments regarding the papers' quality were reported using a letter

code (e.g., R1). The results were presented in Tables for easy interpretation.

## Results and Discussion

The analysis of the reviewers' reports yielded the results concerning the acceptability of the research reports submitted for publication as presented in Table 1. The reviewers' assessment reports which emerged from the ratings of research report quality were analyzed in accordance with the research report structure. The mean values of the reviewers' rating of each section of the research report are shown in Table 2 and interpreted accordingly. For ease of reference, the results presented in Tables are discussed according to the three research questions that provided direction to this study.

### **Answering research questions:**

- (1) **Research Question 1.** What is the journal-conference proceedings acceptance rate of research reports submitted for peer-review during 2014 CEFWA conference?

**Table 1.** Acceptance rate (by number of authors) of research reports submitted for the Journal and conference proceedings publications

Editor's Decision	Number of authors			Total
	Single	Two	Multiple	
Research report accepted outright	-	-	-	0 (0.0%)
Research report accepted with minor revisions	8	4	1	13 (20.0%)
Research report accepted with major revisions	10	7	4	21 (32.3%)
Research report rejected	18	8	5	31 (47.7%)
Total	36	19	10	65 (100.0%)

Whenever CEFWA sends research reports to reviewers, they are expected to provide comments and suggestions on the submission, which are then sent to the author with editorial decision. As shown in Table 1, editorial decisions fall into four main categories: (i) accept without changes (2) decline for now, future acceptance very likely (3) decline for now, future acceptance possible and (4) reject, do not resubmit. Based on the data presented in Table 1, 0.0%, 20.0%, 32.3% and 47.7% fell in category one, two, three and four

respectively. To have a research report accepted after its initial screening is rare even for experienced authors. The finding of no research report falling in the category of “*research report accepted outright*” after reviewers’ rating is not surprising (Rozas & Klein, 2010; Smart et al., 2013) because hardly can one submit a research report for peer review without flaws. Thus, peer review is not merely a difficult stage to get one’s research report published in highly rated journal. It is as much an academic avenue to obtain advice, support and assistance from colleagues in the same field (Cormode, 2013). Only 20.0% of the research reports requires minor revision. In this situation, the editor supports the reviewers’ comments regarding its strengths and weaknesses. Hence, there is need for revision, which may be subjected to re-review before acceptance. Non-conformity to journal referencing style, grammatical and typographical errors, and unsatisfactory explanation of certain points were observed in research reports in the category. The proportion of research reports that required major revision is 32.3%. The editor’s decision to request major revision for 32.3% of the research report is due to the fact they have potential merit and if they are thoroughly revised by addressing all deficiencies, they are likely to be published.

Table 1 revealed that the journal-conference proceedings rejection rate for the year 2014 is 47.7%. The value implies that almost 50% of the research reports were rejected. It is obvious that the higher the acceptance rate, the higher the probability of a research report being accepted. The inferior quality of most of the research reports presented accounts for the value of the journal-conference proceedings rejection rate reported in this paper. Referring to the peer review process that yielded the data presented in Table 1, most research reports were rejected by the CEFWA editors based on reviewers’ negative comments. It is understandable that if a research report is rejected, its reviewers’ narrative comments are quite beneficial to the author in improving the quality of the relevant research report. Most of the research reports were mainly rejected due to the fact that they contained serious flaws in research design, methodology and data analysis techniques. In addition, they were rejected because their contributions to the field were assessed by the reviewers to be sufficiently insignificant in the sense that they appeared to offer nothing new to the existing knowledge. Furthermore, most of the research questions raised to provide directions for the study in rejected research reports were not of interest to the field because they failed to address a serious education problem facing the West Africa sub-region.

In a year, CEFWA can normally produce two journal issues and one referred conference proceedings. Averagely, this cannot accommodate more than 34 quality research reports based on the journal policy. However, with the author’s consent, CEFWA editors do forward a

rejected research report with its reviewers' comments to another journal outlet within the consortium (i.e., journals within the Education Faculties that are CEFWA members) with the hope of getting them published after thorough revision.

**Research Question 2.** How do the reviewers rate the various sections of the research reports submitted for the peer-review process?

**Table 2.** Reviewers' rating of the quality of participants' research reports and samples of major flaws identified in the submitted research reports using the CEFWA Research Report Evaluation Form

S/N	Paper structure	Cluster Mean	Rating	Sample of major flaws
1	Title	3.40	Quite good	(i) title needs to be revised for clarity (ii) purpose and scope of the study not clearly captured in the title. (iii) title not clearly inform the reader of the contents within.
2	Abstract	3.45	Quite good	(i) abstract not precise (ii) sufficient information describing the topic, scope, instrument, data analysis, key findings and recommendations not provided.
3	Introduction	1.86	Quite weak	(i) nature of the problems investigated and why it is of interest were not properly conveyed to the reader. (ii) gaps in knowledge left out. (iii) research questions lacked novelty.
4	Literature Review	2.55	Fairly good	(i) simply paraphrasing precise studies. (ii) very little or no attempt to critically critique the method(s) used in previous studies (iii) failure to capture findings for different studies.
5	Methodology	2.87	Fairly good	(i) flawed methods of sampling (ii) instruments incompletely described (iii) unclear statistical techniques (iv) procedure for data collection not self-explanatory
6	Results	2.71	Fairly good	(i) presented with unclear and inappropriate captions in some cases. (ii) tables not self-explanatory (iii) results not presented clearly and concisely

				(iv) the most important findings not properly summarized in starting discussion. (v) contrast of remarkable findings with earlier findings was left undone. (vi) extent to which the findings resolved the problem(s) addressed is not clearly discussed.
<b>7</b>	<b>Discussion</b>	1.77	Quite weak	
<b>8</b>	<b>Conclusion</b>	2.48	Fairly good	
<b>9</b>	<b>Reference</b>	2.83	Fairly good	

The results of the reviewers’ assessment of the participants’ research reports are presented in Table 2. The Title (M=3.40) and Abstract (M=3.45) were rated by the reviewers as quite good, the Introduction (M=1.86) and Discussion (M=1.77) sections were rated as quite weak, sections on the Review of related Literature (M=2.55), Methodology (M=2.87), Results (M=2.71), Conclusion (M=2.48 and Reference were (2.83) rated by the reviewers as quite weak. The cluster mean value for each section of the research report was determined from the mean scores for the items of the CEFWA Research Report Rating Scale (C3Rs). The basic principle of Likert Scale measurement was applied in calculating the item mean. This principle states that scores yielded by a Likert scale are composite (summated) scores derived from an individual’s responses to the multiple items on the scale (Oppenheim, 1992; Kline, 1998). Samples of major flaws shown in Table 2 are commonly observed flaws as revealed in the reviewer’s comment (Section B of CEFWA Research Report Evaluation Form).

As shown in Table 2, the Introduction and Discussion sections were rated low by the reviewers. Low ratings of these sections were due to defects identified in the research reports submitted for peer review. This result supported Holliday’s (2007) submission that writing the Introduction aspect of a research report is a difficult task for the emerging researchers. According to Biggam (2011), writing quality Introduction requires the writer to perform many complex tasks such as: (1) providing preliminary background information to place the current study in context (2) clarifying the focus of the present study (3) specifying the general and specific purposes of the study and (4) pointing out value of the research. In this research, it was also found that the Discussion sections were inferior in quality. This finding is in consonance with the Kallestinova’s (2011) argument that writing a Discussion section is as difficult as writing the Introduction section of a research report. Kallestinova further stressed that the

uniqueness of every research report in terms of its methods and findings is the key factor that accounts for the difficulties encountered by young researchers.

**Research Question 3.** What are the common flaws in the research reports identified by the reviewers?

Research question 3 is resolved by subjecting the reviewers' comments and suggestions to content analysis through which deficiencies in various sections of the research reports reviewed were identified. A few examples of flaws identified through the content analysis were presented in Table 2 while samples of the reviewers' comments and suggestions regarding the quality of various sections of the research reports are presented in Table 3.

**Table 3.** Samples of the reviewers' comments and suggestions regarding the quality of various sections of research reports

<b>Section</b>	<b>Reviewers' comments and suggestions</b>
<b>Title</b>	<p>"title is rather too long. Not specific and informative enough" (R21)</p> <p>"restructure the title; that is make it precise in order to inform readers about the content therein". (R19)</p>
<b>Abstract</b>	<p>"abnormal length' it exceeded 250 words due to inclusion of irrelevant information" (R15).</p> <p>"provide sufficient information describing the instrument used, the principal findings and the key recommendations in your abstract" (R7).</p>
<b>Introduction</b>	<p>"in revising this section, address the following question (1) why are you interested in this topic? (2) why is this topic worth investigating? Clearly furnish the readers the current state of knowledge on your topic: your review failed to properly situate your work within current studies" (R11)</p> <p>"your introduction is too lengthy. Be brief and let the reader comprehend what your research is all about. It is difficult for me to understand the rationale for this study".(R5)</p>
<b>Literature Review</b>	<p>"what I am expecting to see in this part I did not see it. Presenting catalogue of summaries of selected previous studies is not okay. (R23)</p>

	<p>“inadequate; your review must go beyond presenting summaries of related studies, combine findings from various studies reviewed into an integrative pattern to improve quality of your review” (R8)</p>
<b>Methodology</b>	<p>“the employed study design and procedure for data collection are not sufficiently transparent” (R13)</p> <p>“make your methodology section explanatory enough for the reader. Sampling technique employed inappropriate, preferably stratified sampling techniques will be suitable in this study” (R9)</p>
<b>Results</b>	<p>“rather than presenting your results in prose form, it is better to use tables or graphics” (R17)</p> <p>“tables carrying inappropriate headings” (R3)</p>
<b>Discussion</b>	<p>“your findings are not properly accounted for. No discussion of findings. Enrich this section by clearly explaining the significance of your findings within the context of other research” (R12)</p> <p>“not logically presented; my expectation is that your summary of major findings should be followed by the discussion of the importance of the study’s findings” (R10)</p>
<b>Conclusion</b>	<p>“not satisfactory and it failed to present the key findings of the study. It will be alright if direction for future research is suitably expressed”. (R6)</p> <p>“this section can still be done in a better way, value will be added to this work if its contributions to field of biology education are emphasized” (R4)</p>
<b>References</b>	<p>“this section is not properly done. The reference list is a mix of different styles. Follow the APA referencing format and include all the in-text citations in the reference list. Mismatch between in-text citations and reference list should be corrected (e.g Bello (2000); Bello (2001); Oguniyi (2008); Ogunniyi (2008)” (R24)</p> <p>“Inadequate; many citations not listed. Do not conform to APA format”. (R22)</p>

The preceding results revealed that papers reviewed contained flaws of different types which cut across different sections of research

reports. This corroborates with the existing literature (Pautasso, 2013; Bavdekar, 2015) that reported that most of the rejected papers or papers considered for major revision consisted of many pitfalls. Authors not listing the study limitations, discussing observation not reported in the Results section, Conclusion not supported by data and making recommendations that are not based on the findings are few examples of reported pitfalls.

## **Conclusion and Implications**

This study sets out to identify flaws in research report writing through assessing research reports submitted during an international conference on education organized by CEFWA. The results revealed that the journal-conference proceedings rejection rate for the year 2014 was 47.7%. In reviewers' rating of the different sections of research reports, the Introduction and Discussion sections were rated very low in terms of quality. As revealed in the study, deficiencies in the research reports which accounted for the inferior quality of submitted papers are: (a) title not clearly informing the reader of the content of the writing, (b) study objectives not well-addressed, (c) gaps in knowledge not properly indicated, (d) research questions lack novelty, (e) insufficient methodological explanation, (f) incomplete description of research tools, and (g) results presented not self-explanatory enough. In the author's view, it is possible to remove or minimize flaws in research report prepared for submission if the authors can take the following precautions. (1) reading each section of the research report individually in order to ensure that it contains necessary information and that the research report's contents convey the information in a concise manner. (2) seeking the assistance of colleagues within and outside the author's field in reading the research report with a view to providing constructive feedback and checking for logical flow of ideas.

The educational implication is that there is need for departmental and faculty seminars in the education faculties which can serve as avenue for training in research report writing. Professional associations in the field of education can also assist in this direction by organizing workshops on research report writing targeting both academic staff members and postgraduate students. In such workshops, experienced reviewers and journal editors can be used as resource persons to give specific training on various sections (e.g. Abstract, Introduction) of research reports.

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## Effect of Partially-burnt Paddy Husk as a Supplementary Source of Potassium on Growth and Yield of Turmeric (*Curcuma longa* L.) and Soil Properties

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### Abstract

An experiment was conducted at the Intercropping and Betel Research Station, Narammala, Dampelessa to study the effects of partially-burnt paddy husk as a supplementary source of potassium on growth and yield of turmeric (*Curcuma longa* L.) and soil properties during the year 2017. Seven treatments were prepared by using two sources of potassium, namely Muriate of Potash (MOP) and Partially Burnt Paddy Husk (PBPH). The treatments included T1 (zero potassium fertilizer as control), T2 (recommended rate of MOP 100%), T3 (75% MOP+25% PBPH), T4 (50% MOP+50% PBPH), T5 (25% MOP+75%PBPH), T6 (PBPH alone 100%) and T7 (recommended rate

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of 100% MOP+50% PBPH). For treatment, the percentages of MOP and partially-burnt paddy husk were calculated based on weight basis. This experiment was laid out in a Randomized Complete Block Design with three replications. Local type of turmeric was used as planting material and data were collected on soil, growth and yield parameters of turmeric. Parameters were recorded at monthly intervals after planting. Results revealed that most of the growth and yield parameters have increased in a similar pattern ( $T7>T2=T3>T4>T5>T6>T1$ ). Soil parameters also showed significant differences among the treatments due to the application of PBPH. Quality of the rhizome was evaluated based on colour intensity of the rhizome. There was no significant difference between treatments using colour intensity, except in control treatment (T1). The results obtained by the study showed that combined use of MOP (100%) with PBPH (50%) has beneficial effects on turmeric cultivation. Therefore partially- burnt paddy husk can be used as a supplementary source of K for turmeric cultivation to maximize the yield.

**Key words:** Turmeric, Potassium, partially burnt paddy husk, Fertilizer

## Introduction

*Curcuma longa* L. (Turmeric) is a perennial rhizomatous herb which belongs to Zingiberaceae family. Turmeric is widely used worldwide as a medicine, condiment, dye, and disinfectant and cosmetic. Due to its economic importance, 800 000 tons of turmeric is annually produced in the world, but Sri Lanka only produces 8304 tons (DEA, 2012). Furthermore, there is a good local and export market for turmeric which is grown in Sri Lanka because of its higher curcumin level, especially for organically cultivated turmeric (DEA, 2012). Sri Lanka has the potential to expand turmeric cultivation and earn foreign exchange.

Annually 15-20 tons of turmeric yields can be obtained from 1ha of turmeric cultivation (DEA, 2012). It removes considerable amounts of nutrients from the field. Fertilizer application is essential in order to obtain a sustainable yield from the field and also previous researches have shown that turmeric plant is sensitive for organic manure and potassium fertilizer (DEA, 2012).

### **Problem statement**

Farmers use higher amount of potassium fertilizer than other fertilizer for turmeric cultivation because turmeric plants show a positive response to it (Amarawansa, 2006). There are several disadvantages of using an inorganic fertilizer, including the increased

cost of production. Government is involved in a programme to minimize the utilization of inorganic fertilizer and to promote organic farming (Ministry of Agriculture, 2012) due to the unpopularity of agrochemicals due to perceived health hazards. Therefore, the demand for organic food products has increased. There is a good demand for organically-cultivated turmeric in local and export markets but the production is insufficient. It is important to study the effect of locally available low-cost materials which can be used as supplementary sources of potassium to reduce the total dependence on inorganic fertilizer in turmeric cultivation. It will help to improve organic turmeric cultivation in Sri Lanka. Lack of research and extension programs on organic farming is the principal constraint to the development of productive and profitable organic farming in Sri Lanka (Sangakkara & Katupitiya., 1989).

### **Research justification**

Partially-burnt paddy husk is a locally available low-cost organic material which can be used as a supplementary source of potassium. Partially-burnt paddy husk contains a higher amount of potassium when compared to the organic material (Alwis, 2004). The other benefit of adding partially-burnt paddy husk is its good water holding capacity which helps to retain soil moisture enabling cultivation to proceed even under drought conditions (Amarawansa, 2006). Therefore, the objectives of this study are to investigate the merits/demerits of partially-burnt paddy husk as a supplementary source of potassium for growth, yield and quality of turmeric and on soil parameters.

## **Materials and Methodology**

### **Location**

The study was conducted at a field belonging to the Intercropping and Betel Research Station, Department of Export Agriculture, Narammala, Dampellessa.

### **Treatments**

Table 1 shows the seven treatments prepared using two sources of potassium: Muriate of Potash (MOP) and partially-burnt paddy husk (PBPH). Each of the treatment description is given in Table 1. Percentages of Muriate of Potash (MOP) and the partially burnt paddy husk (PBPH) were decided based on DEA (2012) recommendations.

**Table 1.** Treatment description

Treatment	MOP amount (g/m <sup>2</sup> ) (%)	Partially burnt paddy husk amount (g/m <sup>2</sup> )	Amount of DEA recommended potassium requirement supply by potassium sources g/m <sup>2</sup>	
			MOP%	Partially burnt paddy husk%
T1 (Control)	-	-	-	-
T2 (DEA recommendation)	20	-	100	-
T3	15	230	75	25
T4	10	450	50	50
T5	5	680	25	75
T6	-	900	-	100
T7	20	450	100	50

**Experimental design**

One factor in the RCBD with three replicates were used as the design. The field layout is given below.

**Land preparation**

Land was cleared, ploughed and after that harrowing was done. Twenty-one beds having dimensions of 2.4 m in length and 1.2 m in width were prepared.

**Selection of planting materials and field establishment**

Well matured rhizomes of local type of turmeric, free from pests and diseases were selected. 35-40g parts of rhizomes (seed turmeric rhizomes) were treated with commended fungicide (Mancoseb) and established in the field.

**Fertilizer application**

Partially-burnt paddy husk was prepared by controlled burning. Total amount of partially-burnt paddy husk of each treatment was applied with recommended TSP amount as basal application before field establishment of rhizomes. First application of the MOP amounts of each treatment was done with recommended urea amounts, 45 days

after planting. Second application of MOP with recommended urea amount was done 90 days after planting.

### ***Irrigation***

Plants were watered daily during germinating period except in rainy days. Watering was done manually. In rainy days once a week watering was done to fulfill 1/5 amount of field capacity of the soil. Volume basis method was used to determine the field capacity of one pot.

### ***Data collection***

Data were collected 1, 2, 3, 4, 5 and 6 months after planting based on plant parameters and soil parameters. Plant parameters were measured using randomly selected two plants from each replicate. Quality parameter of the rhizome was evaluated six months after planting.

One month after planting, only plant height and number of emerged plants were measured as plant parameters as the plants were sprouting at that stage.

Data were collected based on plant parameters and soil parameters according to the following methods. Plant parameters are given in Table 2.

**Table 2.** Methods of measuring plant parameters

<b>Parameter</b>	<b>Method</b>
Plant height	Taken from the ground level to the tip of the longest shoot.
Number of plants emerged from the soil	Counted in each replicate.
Number of leaves per clump	Counted in randomly selected two plants from each replicate.
Stem diameter	Measured by using a Vernier Caliper at the top, middle, and bottom of stem and the average was calculated and expressed in centimeters.
Fresh and dry weight of the rhizome	Rhizome was cleaned and the fresh weight immediately measured while dry weight was obtained by keeping the rhizome at 70°C until a constant weight was seen.
Number of rhizome fingers	Two rhizomes were taken from each replicate and the numbers of rhizome fingers were counted.
Fresh total biomass weight	Two plants from each replicate were taken and fresh weight of the total plant was immediately measured by using electronic balancer.
Number of roots	Counted using two plants from each replicate.
Quality of the rhizome	Color intensity of the rhizome was measured using a spectrophotometer (CT-5100 UV/VIS Spectrophotometer). Pure turmeric juice samples (3ml) were prepared using 25g of fresh turmeric rhizome from each sample. The wave length at which maximum absorbance ( $\lambda$ max) took place in UV detector (430 nm) was selected for further analysis. The absorbance of each sample was then measured at 430nm against distilled water as blank. Six samples were analyzed for each treatment and the mean values of absorbance were taken to compare color intensity of rhizomes.

### **Soil parameters**

(i) N, P, K content of soil samples

N and K content of soil samples were measured using the Kjeldahl method and Ammonium Acetate extraction method at the Cinnamon Research Station Matara. P content of soil samples was measured using the Vandatemolybdate method at the Soil and Water Laboratory of the Department of Agricultural and Plantation Engineering, The Open University of Sri Lanka.

(ii) Soil moisture content

Two soil samples were taken from each replicate by using a soil core sampler at 10-30cm depths. Wet weights of the soil samples were taken and samples were kept at 105°C temperature in oven until weight became constant. The dry weight was subtracted from wet weight to obtain moisture content of the soil and then it was converted to a percentage.

(iii) Soil pH and Soil EC

Soil pH was measured using a pH meter. Soil EC was measured using the HANNA digital EC meter.

### **Data analysis**

All of above-mentioned data were subjected to Analysis of Variance (ANOVA) using the SAS software package. Mean separation was done by Least Significant Difference Test (LSDT) at 0.05 level of probability.

## **Results and Discussion**

### **1. Soil parameters**

#### **Soil moisture content**

During every month the highest moisture content percentage was observed in treatments T5 (75% PBPH+25%MOP) and T6 (100%PBPH) and the lowest moisture content percentage was observed in the treatment T1 (Control) and T2 (100% MOP). Significantly, the highest percentage of moisture content was observed in treatment T6 (100% PBPH) and the lowest value in treatment T1 (Control) at the sixth month (Table 3). However, there is no significant difference between treatment T6 and T5 at the sixth month. Moisture content has increased in accordance with the amounts of partially-burnt paddy husk applied. The reason may be the higher water holding capacity of partially-burnt paddy husk (Amarawansha, 2006).

#### **Soil EC**

The highest EC values were observed in the 2<sup>nd</sup> month probably due to the first application of inorganic fertilizer at 45 days after planting. Significantly highest EC value was observed in treatment T7 (100% MOP + 50% PBPH) and the lowest EC value was observed in treatment T6 (Table 3) at the sixth month. Treatment T7 is significantly different from treatment T6 but not significantly different from treatment T2 (100% MOP). Initial PBPH sample showed higher EC value of 2.21 and PBPH may have an effect on soil EC alone but Lehmann and

Joseph (2009) reported that biochar increases nutrient retention on the top soil by lowering the amount of nutrient leached into lower layers of soil or into ground water and it supports the result of T7 having higher EC than T6.

**Table 3.** Soil parameters measured at the sixth month afterplanting

<b>Treatments</b>	<b>Soil Moisture Content (%)</b>	<b>Soil electrical conductivity (mS/m)</b>	<b>Soil pH</b>	<b>Soil N (%)</b>	<b>Soil P (ppm)</b>	<b>Soil K (%)</b>
T1(Control)	4.87 <sup>d</sup>	0.5 <sup>de</sup>	6.41 <sup>cd</sup>	0.17 <sup>a</sup>	285 <sup>a</sup>	0.012 <sup>e</sup>
T2 (100%MOP).	5.12 <sup>d</sup>	1.0 <sup>ab</sup>	6.28 <sup>d</sup>	0.18 <sup>a</sup>	289 <sup>a</sup>	0.025 <sup>ab</sup>
T3 (75% MOP +25% PBPH)	8.94 <sup>c</sup>	0.9 <sup>bc</sup>	6.53 <sup>bcd</sup>	0.18 <sup>a</sup>	290 <sup>a</sup>	0.024 <sup>abc</sup>
T4 (50% MOP + 50% PBPH)	10.65 <sup>b</sup>	0.73 <sup>c</sup>	6.7 <sup>abc</sup>	0.17 <sup>a</sup>	276 <sup>a</sup>	0.021 <sup>bcd</sup>
T5 (75%PBPH+ 25%MOP)	15.65 <sup>a</sup>	0.7 <sup>cd</sup>	6.73 <sup>ab</sup>	0.18 <sup>a</sup>	300 <sup>a</sup>	0.017 <sup>ade</sup>
T6 (100% PBPH)	15.8 <sup>a</sup>	0.4 <sup>c</sup>	6.84 <sup>a</sup>	0.18 <sup>a</sup>	294 <sup>a</sup>	0.016 <sup>de</sup>
T7 (100%MOP+ 50%PBPH)	10.66 <sup>b</sup>	1.2 <sup>a</sup>	6.68 <sup>abc</sup>	0.18 <sup>a</sup>	298 <sup>a</sup>	0.029 <sup>a</sup>

### **Soil pH**

Soil pH showed decreasing trend from the 1<sup>st</sup> month up to the 6<sup>th</sup>, but when compared with the initial value of soil pH (6.26), pH values have slightly increased (Table 3). Initial PBPH sample showed higher pH value of (8.1). Application of partially-burnt paddy husk increases soil pH (AICOAF, 2001) and this may be the reason for the increased pH values in treatments.

In the sixth month the highest pH value was observed in treatment T6 (100% PBPH) and the lowest pH value in treatment T2 (100% MOP) (Table 3). Treatment T6 is significantly different from treatment T2. pH values of treatments with higher amount of PBPH (T5 and T6) have shown significant differences from the treatments which did not involve PBPH (T1 and T2). Reason for the decreasing trend of pH values may be due to the application of urea, 45 days and 90 days after planting and soil pH decreases after application of the urea due to acidification resulting from dissociation of urea to produce H<sup>+</sup> ions.

### **Available Nitrogen**

There is no significant difference among the treatments applied to soil with available nitrogen six months after planting (Table 3), but when compared to the available N in the initial soil (0.16%), N values of all the treatments have slightly increased. The reason for the increased N level may be due to the application of urea, 45 and 90 days after planting. All the treatments received equal amounts of nitrogen fertilizer (urea) in the same manner and this may be the reason for no significant differences among the treatments.

### **Available Phosphorus**

There is no significant difference among the treatments applied to soil with available phosphorus six months after planting (Table 3), but when compared to the initial soil available P value (270ppm), P values of all the treatments have slightly increased. The reason for the increased P level may be due to the application of TSP, 45 and 90 days after planting. All the treatments received equal amount of phosphorus fertilizer (TSP) in the same manner and this may be the reason for no significant differences among the treatments.

### **Available Potassium**

Soil with available potassium shows significant differences among treatments six months after planting (Table 3), but when compared to the initial soil potassium content (0.015%), potassium content of all the treatments, except T1(Control), have increased slightly (Table 3). The reason for the increased potassium levels may be due to the potassium fertilizers and PBPH contained in those treatments. In the 6<sup>th</sup> month the highest available potassium value was observed in treatment T7 (100%MOP+50%PBPH) and the lowest available was observed in treatment T1 (Control). Treatment T7 is significantly different from treatment T1. Treatment T7 contained the highest amount of potassium and treatment T1 contained no potassium. This may be the reason for the above observation. The reason for the variation of potassium content among the other treatments may be due to the different ratios of potassium sources (MOP: PBPH) contained in the individual treatments.

## **2. Growth parameters**

### **Number of emerged plants**

Number of emerged plants showed an increasing trend. Treatment T6 (100% PBPH) showed the significantly highest number of emerged plants in the 1<sup>st</sup> and the 2<sup>nd</sup> months. Treatments T1 (Control) and T2 (100%MOP) have showed the lowest number of emerged plants. In

the second month, treatment T6 showed the significantly highest number of emerged plants (Table 4). There is a significant difference between treatments which have applied PBPH and treatments which have not. Soil moisture is important for germination and soil moisture content vary depending on the amount of added partially-burnt paddy husk. Treatment T6 contains the highest amount of PBPH and it may be the reason for the highest number of emerged plants.

### **Plant height**

Plant height showed an increasing trend from the 1st month up to 6<sup>th</sup>. Plant height has increased in a similar pattern as follows: T7>T2=T3>T4>T5>T6>T1. Significantly the highest plant height was observed in treatment T7 (50%PBPH+100%MOP) and the lowest was observed in treatment T1 (Control) the sixth month (Table 4). Treatment T7 is significantly different from treatment T1. The reason for the increasing trend of plant height may be due to the quick response in the application of inorganic fertilizer, 45 days and 90 days after planting. The plant height has increased proportionally to the amount of MOP contained in the treatments. Noor *et al* (2014) have reported that the increased plant height in turmeric crop could be due to increasing K fertilizer. Treatments T2 and T7 contains the same amount of MOP, but the additional amount of PBPH in treatment T7 may be the reason for the significant difference between treatments T2 and T7. Furthermore, treatment T6 (100%PBPH) showed higher plant height than treatment T1 (Control) because treatment T6 has PBPH and Graber (2010) has reported increased plant height in tomato crop due to biochar application.

**Table 4.** Growth parameters measured on the 6th month afterplanting.

<b>Treatments</b>	<b>Emerged plants (%)</b>	<b>Plant height (cm)</b>	<b>Number of Leaves</b>	<b>Stem diameter (cm)</b>
T1(Control)	56.3 <sup>c</sup>	127.7 <sup>d</sup>	9.3 <sup>d</sup>	2.6 <sup>d</sup>
T2 (100%MOP).	59.4 <sup>c</sup>	149.4 <sup>b</sup>	11.0 <sup>b</sup>	3.2 <sup>b</sup>
T3 (75% MOP +25% PBPH)	71.9 <sup>b</sup>	148.8 <sup>b</sup>	10.8 <sup>bc</sup>	3.1 <sup>b</sup>
T4 (50% MOP + 50% PBPH)	75 <sup>b</sup>	139.5 <sup>c</sup>	10.0 <sup>bc d</sup>	2.9 <sup>c</sup>
T5 (75% PBPH+25%MOP)	78.1 <sup>b</sup>	137.9 <sup>c</sup>	9.8 <sup>bc d</sup>	2.9 <sup>c</sup>
T6 (100% PBPH)	90.6 <sup>a</sup>	136.7 <sup>c</sup>	9.7 <sup>cd</sup>	2.9 <sup>c</sup>
T7 (100%MOP+50%PBPH)	75 <sup>b</sup>	157 <sup>a</sup>	12.3 <sup>a</sup>	3.5 <sup>a</sup>

### **Number of leaves**

The number of leaves showed an increasing trend from the 2<sup>nd</sup> month up to the 6<sup>th</sup>. Significantly the highest number of leaves was observed in treatment T7 (50%PBPH+100%MOP) and the lowest in treatment T1 (Control) on the sixth month (Table 4). Treatment T7 is significantly different from treatment T1. The reason for the above observation may be due to the quick response of application of inorganic fertilizer, 45 days and 90 days after planting.

The number of leaves has increased proportionally to the amount of MOP contained in the treatments. Annie *et al* (2002) have recorded increased number of leaves in turmeric crop due to increasing potassium fertilizer. Treatments T2 and T7 contained the same amount of MOP but the additional amount of PBPH in treatment T7 may be the reason for the significant difference between treatments T2 and T7.

### **Pseudo diameter**

Pseudo stem diameter showed an increasing trend from the 2<sup>nd</sup> month up to the 6<sup>th</sup>. Significantly the highest pseudo stem diameter was observed in treatment T7 (50%PBPH+100%MOP) as shown in Table 4. The reason for the above observation may be due to the quick response in the application of inorganic fertilizer, 45 days and 90 days after planting. Pseudo stem diameter has increased proportionally to the amount of MOP contained in the treatments. Annie *et al* (2002) have recorded an increased pseudostem girth in turmeric crop correlating with the K fertilizer level.

## **3. Yield Parameters**

### **Number of rhizome fingers**

The number of rhizome fingers shows an increasing trend from the 2<sup>nd</sup> month up to the 6<sup>th</sup> month. The number of rhizome fingers has increased in a similar pattern as follows: T7>T2=T3>T4>T5>T6>T1 (Table 5). Treatment T7 is significantly different from treatment T1. The reason for the above observation may be due to the quick response of the application of inorganic fertilizer, 45 days and 90 days after planting. The number of rhizome fingers has increased proportionally to the amount of MOP contained in the treatments. Annie *et al.* (2002), Karthikeyan *et al.* (2009) have recorded increased number of rhizome fingers in turmeric crop due to increased K fertilizer.

**Table 5.** Yield parameters measured on the 6th month after planting

Treatments	Number of rhizome fingers	Fresh weight of rhizome (g)	Dry weight of rhizome (g)	Fresh Biomass weight of plant (g)
T1(Control)	11.5 <sup>d</sup>	139.5 <sup>d</sup>	18.1 <sup>d</sup>	339.5 <sup>d</sup>
T2 (100%MOP).	14.0 <sup>b</sup>	172.1 <sup>b</sup>	22.4 <sup>b</sup>	372.1 <sup>b</sup>
T3 (75% MOP +25% PBPH)	13.9 <sup>b</sup>	171.3 <sup>b</sup>	22.3 <sup>b</sup>	371.3 <sup>b</sup>
T4 (50% MOP + 50% PBPH)	13.0 <sup>c</sup>	164.2 <sup>c</sup>	21.3 <sup>c</sup>	364.2 <sup>c</sup>
T5 (75% PBPH+25%MOP)	13.0 <sup>c</sup>	163.5 <sup>c</sup>	21.3 <sup>c</sup>	363.5 <sup>c</sup>
T6 (100% PBPH)	12.7 <sup>c</sup>	162.5 <sup>c</sup>	21.1 <sup>c</sup>	362.4 <sup>c</sup>
T7 (100%MOP+50%PBPH)	15.0 <sup>a</sup>	177.6 <sup>a</sup>	23.1 <sup>a</sup>	377.6 <sup>a</sup>

#### **Fresh weight of the rhizome**

Fresh weight of the rhizome showed an increasing trend from the 2<sup>nd</sup> month up to the 6<sup>th</sup>. The fresh weight of the rhizome has increased in a similar pattern as follows: T7>T2=T3>T4>T5>T6>T1 (Table 5). Significantly the highest fresh weight of rhizome (177.6 g) was observed in treatment T7 and the lowest weight (139.5g) in control treatment T1. The reason for the above observation may be due to the quick response of the application of inorganic fertilizer, 45 days and 90 days after planting. The fresh weight of rhizome has increased proportionally to the amount of MOP in the treatments. This result agrees with the results of Annie *et al* (2002) as the fresh weight increased with increased potassium fertilizer. Furthermore, fresh weight of the rhizome has increased according to the method of using, zero fertilizer (T1) < organic fertilizer alone (T6) < chemical fertilizer alone (T2) < combined use of organic and chemical fertilizer (T7). These results agree with the results of HARTI (2013).

#### **Dry weight of the rhizome**

The dry weight of the rhizome also followed the same pattern as the fresh weight of rhizomes. The dry weight of the rhizome has increased in a similar pattern to the fresh weight of the rhizome (T7>T2=T3>T4>T5>T6>T1 (Table 5). The significantly highest dry weight of rhizome (23.1g) was observed in T7 with 100% MOP and 50% of PBPH. The lowest dry weight of rhizome (18.1g) was observed in control treatment T1. The reason for the above observations may

be due to the quick response of the application of inorganic fertilizer, 45 days and 90 days after planting. Dry weight of the rhizome has increased proportionally to the amount of MOP in the treatments and this result is supported by the results of Karthikeyan *et al* (2009). PBPH may also have an effect on dry weight of the rhizome. Priyadarshini & Seran (2009) reported that increased dry weight of cowpea pods due to application of PBPH.

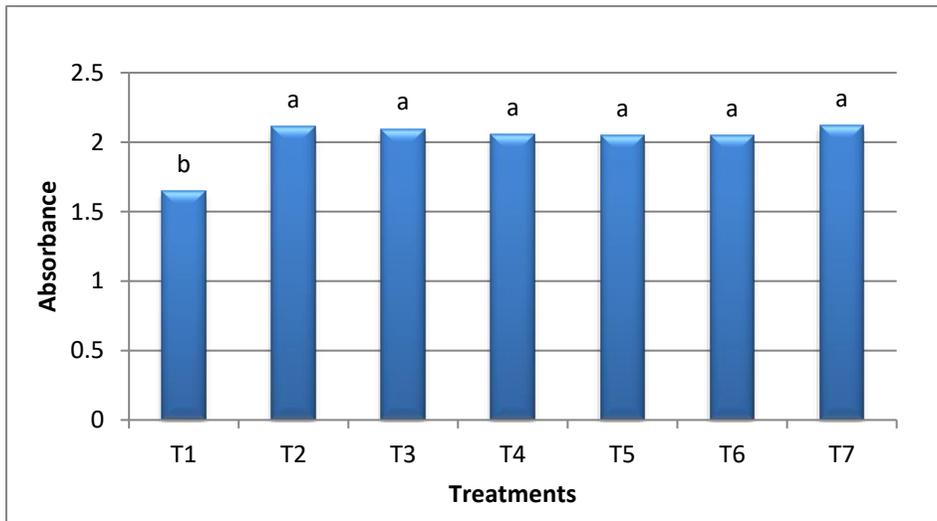
### ***Fresh biomass weight of plant***

The fresh biomass weight showed an increasing trend from the 2<sup>nd</sup> month up to the 6<sup>th</sup>. The fresh biomass weight has increased in a similar pattern as follows: T7>T2=T3>T4>T5>T6>T1 (Table 5). Significantly the highest fresh biomass weight of plant (377.6g) was observed in treatment T7 and the lowest (339.5g) in control treatment T1. The reason for the above observations may be due to the quick response of the application of inorganic fertilizer, 45 days and 90 days after planting. The fresh biomass weight of plant has increased proportionally to the amount of MOP in the treatments. Karthikeyan *et al.* (2009) reported that increasing the application rate of potassium in the form of KCl enhanced the growth of turmeric. Priyadarshini & Seran (2009) reported increased fresh biomass weight of cowpea plant except their roots due to the application of PBPH. There may be a combined effect of MOP and PBPH on the fresh biomass weight of turmeric as observed in this study.

## **4. Quality parameter**

### ***Colour intensity of the rhizome***

There is a significant difference between treatment T1 (Control) and all the other treatments (T2, T3, T4, T5, T6, T7) (Fig. 1). HARTI (2003) mentioned that the quality of the turmeric rhizome differs with its colour and the reason for the yellow colour of the rhizome is curcumin. These results indicate that there is no significant difference among the treatments on the quality of turmeric except in treatment T1. When compared with all the other treatments, treatment T1 might have contained relatively a lower curcumin amount and all the other treatments might have contained nearly equal amounts of curcumin but higher than the control treatment. This may be due to the fact that treatment T1 (control) did not contain any potassium source and Akamine *et al.*(2007) reported that potassium is the principal element involved in curcumin formation in turmeric.



**Figure 1.** Absorbance of curcumin (means with the same letter is not significantly different)

## Conclusions and Recommendations

According to the above observations, the combined use of MOP with PBPH has shown beneficial effects on turmeric cultivation. Partially-burnt paddy husk has beneficial effects as a supplementary source of potassium for growth of turmeric and it enhances the effects of MOP on the growth, yield and quality of turmeric. Therefore, farmers are advised to use partially-burnt paddy husk to dissolve and retain inorganic fertilizer in the soil. It also helps to improve the efficiency of applied inorganic fertilizer in order to increase the yield.

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## Perceived Factors Related to Delayed Presentation of Breast Cancer among Women with Stage III and IV Breast Cancer in Sri Lanka

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### Abstract

The most common cancers to be diagnosed in women are breast, lung, and colorectal cancers, which when combined represent one-half of all the cancer cases; breast cancer alone accounts for 30% of all new cancer diagnoses in women. Hence breast cancer becomes the most common cause for cancer deaths worldwide among women. Delay in presentation of breast cancer causes increase morbidity, mortality and decreased survival rate of these patients. Therefore,

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this study was conducted to examine the perceived factors related to delayed presentation of breast cancer among women. One hundred

and fifty-one female patients with breast cancer stage III and IV, admitted to the Oncology ward and Oncology clinic in the Teaching Hospital, Kandy, were purposively recruited for this quantitative descriptive study. Self-administered questionnaire was used to collect data. Study was conducted during the period January to April 2016. The results highlighted that 67% of patients were unaware of the symptoms of breast cancer. Further, 29% of patients deliberately delayed treatment due to perceived embarrassment in exposing their breasts to medical practitioners; 44% of patients followed the same course of action due to perceived fear of partner abandonment. Significantly, 76% of patients were not aware of self-breast examination method whereas 78% never attended the “Well Women Clinic” (*Suwa Nari Sayanaya*) which is conducted for the improvement of women’s health. Furthermore, 83% of the patients did not have family histories of breast cancer. The findings concluded that the lack of awareness among patients on symptoms and the self-breast examination method, never attending Well Women Clinic, fear of partner abandonment, perceived embarrassment in disclosing breasts to medical practitioners and negative family histories were common factors related to delayed presentation of breast cancer among women. Therefore, it is recommended to establish effective public awareness programs to increase early diagnosis, prognosis, survival rate and improve overall quality of life among patients with breast cancer.

**Key words:** Breast cancer, delayed presentation, women and perceived factors

## Introduction

Cancer is an abnormal growth of the cells. When it occurs in the glandular breast tissue, it is known as breast cancer (Asoogo & Duma, 2015). Breast cancer is the most commonly occurring cancer in women and the second most common cancer overall. It is constantly increasing worldwide. Breast cancer accounts for 16% of adult deaths in the world (World Health Organization, 2008). It is estimated that annually, more than one million women are diagnosed with breast cancer (Ferlay et al., 2010). Approximately 40,290 women were expected to die from breast cancer in 2015 (Tarver, 2012). There were over two million new breast cancer cases in 2018 (Bray et al., 2018).

According to the World Health Organization (2008), breast cancer deaths in Sri Lanka reached 1,361 per year or 1.07% of total deaths.

A study conducted in Sri Lanka found that most of the patients with breast cancer were detected at an advanced stage which lowered the five-year survival rate (Kumari & Goonewardena, 2011).

Breast cancer can be classified into five stages based on the characteristics of cancer. The stage of the breast cancer further indicates the average five-year survival rate (Table 1). It is also important to determine prognosis and to decide the best treatment option for cancer (National Cancer Control Programme, 2016).

**Table 1.** Classification of breast cancer based on cancer Characteristics

<b>Stage</b>	<b>Extent of spread</b>	<b>Average 5 years survival rate (%)</b>
0	Non-invasive cancer	99
I	Small invasive cancer (less than 2 cm without spreading to the axillary lymph nodes)	90
II	Invasive cancer (between 2-5 cm or/with lymph nodes invasion)	70
III	Large invasive cancer (more than 5 cm with skin invasion or spread to multiple lymph nodes)	40
IV	Widespread metastatic cancer	or 20

(Note. Reprinted from *Cancer Incidence Data, Sri Lanka, 2010* of the National Cancer Control Programme Sri Lanka, 2016, Ministry of Health, 56)

According to the classification of breast cancer based on cancer characteristics, stage III and IV considered for this study are patients presented with those stages which are irreversible and difficult to cure (Tarver, 2012). Delayed presentation of breast cancer is defined as patients who do not undergo medical consultation even after detecting breast abnormalities by themselves within a 3-month duration (Khan et al., 2015). There are two types of delayed presentation for the diagnosis of breast cancer, namely Patient Delay and System Delay (Asoogo & Duma, 2015). Patient delay is the time interval from onset of symptoms to the act of seeking medical advice. System or Provider Delay is the delay between first clinical appointments to initiation of proper treatment (Asoogo & Duma, 2015). However, in many occasions both types were present together (Montazeri et al., 2003).

Delayed diagnosis of breast cancer causes larger tumor size, increase involvement of the lymph nodes and organ metastases (Asoogo & Duma, 2015). Therefore, the delayed presentation and detection of breast cancer causes poor prognosis thus lowering the rate of survival. It can also have negative effects on the quality of life due to increase psychological stress and the use of more toxic treatment due to the severity of the cancer (Asoogo & Duma, 2015). Therefore, early diagnosis of breast cancer is essential for the proper management and treatment of the disease (Norsa'adah et al., 2011). Early diagnosis increases access to mammographic screening and access to effective treatment that have been reported in developed countries. However, in developing countries low screening and absence of mammography facilities have affected the delayed presentation of breast cancer.

Many factors are associated with delayed presentation of breast cancer such as lack of awareness regarding the symptoms (breast lump, nipple discharge, breast pain, nipple retraction), poor knowledge of screening methods (eg. self-breast examination which includes regular examination of one's own breasts to detect any breast abnormalities), financial difficulties and social stigma (Asoogo & Duma, 2015; Stapleton et al., 2011). Furthermore, majority of patients have delayed seeking medical consultation due to fear for cancer treatment, traditional and spiritual believes; they have also wasted time using alternative medication; social stigma attached to exposing their breasts to health care professionals, poor family support, thoughts or misconceptions such as symptoms were not serious and it would go away immediately (Ali et al., 2008; Asoogo & Duma, 2015; Malik & Gopalan, 2003; Stapleton et al., 2011).

Ferlay et al. (2014) pointed out that almost 50% of breast cancer patients and 58% of breast cancer deaths in the world occurred in the developing countries. This highlighted that breast cancer is a major public health concern and needs the attention of relevant authorities urgently. In Sri Lanka, studies conducted on breast cancer are limited. However, a study conducted in Colombo has found that low income and not attending the Well Women Clinic which is conducted for women's health, causes delayed presentation of breast cancer among Sri Lankan women (Kumari & Gunawardhana, 2011). Perera et al. (2004) revealed that lack of national breast cancer screening programme was one of the main reasons for delayed diagnosis of breast cancer in Sri Lanka. Kuruppu et al. (2015) mentioned that knowledge of risk factors, symptoms, screening/diagnosis methods and services provided to general public through the Well Women Clinic were poor. Therefore, understanding the perceived factors related to delayed presentation of breast cancer is vital in order to establish public awareness programs to encourage women to seek proper health care as early as possible. Women need

to be aware about the clinical symptoms and proper knowledge regarding breast cancer to increase the chance of early detection and thereby minimize mortality and morbidity rates. Therefore, the purpose of the study was to examine the perceived factors related to delayed presentation of breast cancer among female patients with breast cancer stage III and IV in the Kandy Teaching Hospital. The specific objectives of the study were to determine the perceived factors leading to delayed presentation of breast cancer in relation to socio demographic, knowledge, attitudes and socio-economic aspects of these patients.

## **Methodology**

### ***Study design***

A quantitative descriptive research design was utilized in this study. The quantitative research approach is best suited to focus on determining factors and examining causes (Kothari, 2008) on the delayed presentation of breast cancer. As the nature of the descriptive research design, it helps the exploration and description of phenomena in real-life situations of these women with breast cancer. Therefore, the descriptive design helps to describe the perceived socio demographic, knowledge, attitudes and socio-economic factors leading to delayed presentation of breast cancer among women with Stage III and IV breast cancer in Teaching Hospital, Kandy.

### ***Ethical considerations***

Ethical approval was granted by the Ethics Review Committee, Teaching Hospital Kandy. Institutional approval was also obtained from the director of the hospital. Permission was sort from the consultants in female Oncology wards and clinic at Teaching Hospital, Kandy, prior to commencement of the study. Voluntary participation was encouraged. Written informed consent was obtained from every participant after informing benefits and risks of the study (Bailey, 2008). Privacy and confidentiality of participants were assured throughout the study. Participants were convinced about their right to withdraw from study at any time without any penalty.

### ***Study setting and participants***

The study was conducted at the female Oncology wards and clinic at Teaching Hospital Kandy. The Oncology wards and clinic in Teaching Hospital Kandy is responsible for treatment and minimizing of all

cancer incidents in the Kandy district. The female Oncology ward consists of three sections coming under three consultants. Participants were purposively selected for this study as researchers wanted to identify the patients who were in the late stages of breast cancer (stage III and IV). The sample size was calculated based on the Cochran formula (Statistics, 2018) and accordingly 151 female patients attending Oncology wards and clinic at the Teaching Hospital, Kandy were recruited for this study. The women who were histologically diagnosed as breast cancer stage III and IV and aged above 20 years were used as the inclusion criteria.

### **Data collection and analysis**

Data collection was carried out from January to May 2016. Pre-tested self-administered questionnaire was used to collect data from the study participants. The questionnaire was prepared in English language and translated into Sinhala and Tamil language. It consisted of 47 questions in four parts which contained socio demographic information such as age, education, and religion, knowledge related to symptoms of breast cancer and early diagnosis methods, attitudes such as fear and embarrassment, and socio-economic factors like transport difficulties and low income which contribute to delayed presentation of breast cancer. Content validity of the questionnaire was assessed by referring to the standard literature and subject experts in the field of Oncology and Community Medicine. Test-retest reliability was maintained. Data analysis was carried out with descriptive statistics using Statistical Package for the Social Science (SPSS) version 22 software.

### **Results and Discussion**

The response rate was 98.05%. The data was presented under four main categories: socio demographic factors, factors related to knowledge, attitudes and socio-economic factors.

#### **Socio demographic factors**

Among the study participants, majority (55%, n=83) were above 51 years. They were the high-risk group that is vulnerable to breast cancer among the study participants. The mean age of all participants was  $45.5 \pm 1.6$  years (range 27-59 years). Age is considered as the most important risks factor for breast cancer as it gradually increases with age. It is rare for those who are under twenty years. Majority of cases are reported between 45 and 65 years. This is most probably attributed to hormonal imbalance in this age due to menopause (Mensah et al., 2015).

Seventy five percent of patients were married. Furthermore, 83 % of patients were followers of Buddhism. Besides, 33% of patients were educated up to the Advanced Level of General Certificate of Education (G.C.E A/L). The study results further revealed that over one third of

late presented patients with breast cancer were educated only up to grade eight (Table 2). This might have highlighted that their deficiency of understanding the symptoms and severity of the disease.

**Table 2.** Socio demographic factors related to delayed presentation of breast cancer

<b>Socio factors</b>	<b>demographic</b>	<b>Frequency (n=151)</b>	<b>(%)</b>
Age	20 – 30 years	3	2.0
	31 – 40 years	23	15.2
	41 - 50 years	42	27.8
	>51 years	83	55.0
Religion	Buddhism	126	83.4
	Hindu	14	9.3
	Islam	11	7.3
Education level	No formal education	17	11.3
	Up to grade 8	48	31.8
	Up to G.C.E O/L	29	19.2
	Up to G.C.E A/L	49	32.5
	Higher education	8	5.3
Civil status	Single	10	6.6
	Married	114	75.5
	Widowed	13	8.6
	Divorced	14	9.3

***Knowledge related to delayed presentation of breast cancer***

In view of the knowledge regarding breast cancer, 67% (n=101) of delay-presented patients were not aware of breast cancer symptoms. Only 19% (n=28) of patients were aware that the lump could be a breast cancer. The same finding was presented by Montazeri et al. (2003). According to the present study findings, 50% of the participants knew that the breast cancer can be cured if detected early. The study findings highlighted that 60% (n=90) of delay-presented patients with breast cancer have taken medical consultation after three month of initiation symptoms while 21% (n=32) of patients received medical consultation after it became worse.

**Table 3.** Knowledge related to delayed presentation of breast Cancer

<b>Knowledge related to delayed presentation</b>	<b>Frequency (n=151)</b>	<b>(%)</b>
<b>Knowledge of symptoms of breast cancer</b>		
breast lump may be due to a breast cancer	28	18.5
breast pain may be due to a breast cancer	15	9.9
breast enlargement may be due to a breast cancer	5	3.3
nipple discharge may be due to a breast cancer	12	8
not known	101	66.9
<b>Seeking medical consultation for symptoms</b>		
after it got worse	32	21.2
after three months	90	59.6
as soon as possible	29	19.2
Known that breast cancer can be cured by early detection	75	49.7
Having knowledge of self-breast examination	36	24
Not having knowledge of self-breast examination	115	76.2
Never done self-breast examination	120	79.5
<b>Knowledge regarding the Well Women Clinic</b>		
detect illnesses of women	49	32.5
giving health education	14	9.3
Not aware about Well Women Clinic	96	63.6
Never attending Well Women Clinic	118	78.1

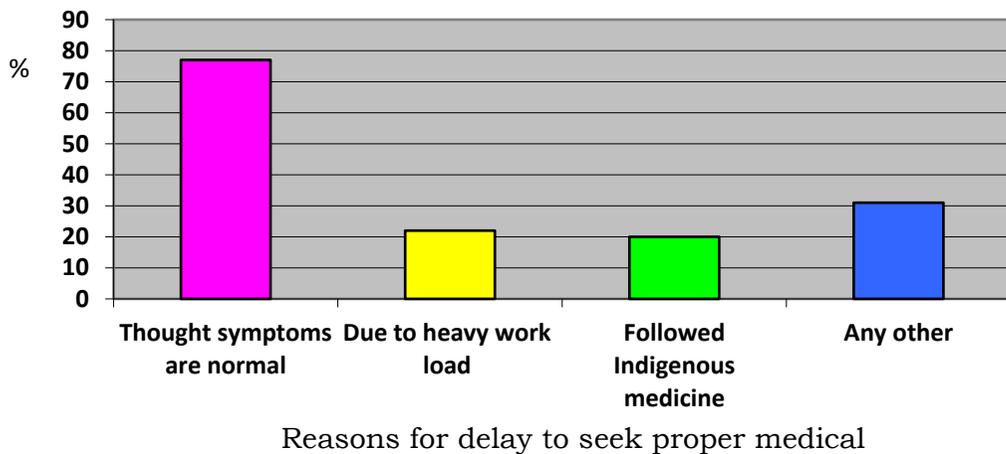
Moreover, 51% (n=77) of patients had thought their symptoms were normal and delayed medical consultation. Fourteen percent of patients delayed taking medical consultation due to heavy work load at home or work place.

The patients who knew self-breast examination method were 24% (n=36). However, out of these 36 patients, 5 patients did not practice it. Significantly, 80% (n=120) of patients had never carried out a self-breast examination. Similar results were presented by a contemporary research carried out in Jordan (Suleiman, 2014). It disclosed that majority of patients with breast cancer presented delay was due to lack of screening for breast cancer or performing self-breast examination. In Egypt, approximately half of women with breast cancer suffered a similar fate due to the lack of knowledge of self-breast examination (Stapleton et al., 2011). Lannin et al. (1998) pointed out that majority of patients with breast cancer delayed seeking medical consultation due to the failure of identifying initial breast cancer symptoms and not practicing self-breast examination regularly.

Further, the study illustrated that 78% of patients never attended to Well Women Clinic and 64% (n=96) patients had not known about

this clinic. Even in the United State, it was found that patients with poor attendance to early breast cancer diagnosis centers were reported (Grinfeld et al., 2002). However, the authors further highlighted that the society should be informed that deaths related to breast cancer are attributed to the advanced stages of the disease and reporting too late for medical treatment.

According to the present study 20 % of patients wasted time on indigenous and alternative traditional medication after detecting symptoms (Fig. 1). Globally, complementary and alternative medicines are common among women with breast cancer due to cultural influences. This is one of the main reasons for delayed presentation of breast cancer (Donker et al. 2015). Two main types of alternative medicine were identified by Donker et al. (2015). These were local based therapies (spiritual/prayer/traditional healer/herbal therapy), and foreign-based therapies (acupuncture/homoeopathy/Chinese medicine). Many studies have shown that patients with breast cancer relied mainly on alternative medicine after detecting breast cancer symptoms, to heal or cure the disease especially in the initial stage of the breast cancer (Ali, et al., 2008; Asoogo & Duma, 2015; Malik & Gopalan, 2003; Stapleton et al., 2011).



**Figure 1.** Reasons for delay to seek proper medical consultation

**Attitudes related to delayed presentation of breast cancer**

When considering the attitudes of delayed presented patients, 38% (n=58) were afraid of hospitalization and surgery. As shown in the table 4, 29% (n=43) of participants were embarrassed at exposing their breast to a medical practitioner. It was one of the main causes for seeking medical consultation quite late. However, contribution of

other psychological factors such as: fear of unbearable pain during treatments (30%, n=46), fear of losing a breast (29%, n=43), fear of partner abandonment (44%, n=67) cannot be disregarded. Study results further highlighted that 31% of participants believed that after getting cancer treatment, the disease condition could get worse (Table 4). Asogo & Duma (2015) argues that the negative thoughts such as fear of detecting breast abnormality, fear of partner abandonment, social stigma attached to exposing breasts to health care professionals were barriers to early detection of breast cancer cases. Moreover, the results highlighted that about one third of the patients with breast cancer delayed seeking medical consultations due to the fear for loss of the breast/mastectomy and chemotherapy which are the most common treatments for breast cancer management (Table 4).

**Table 4.** Attitudes related to delayed presentation of breast Cancer

<b>Attitudes related to delayed presentation</b>	<b>Frequency (n=151)</b>	<b>(%)</b>
Fear of hospitalization and surgery	58	38.4
Embarrassment in exposing breasts to a medical practitioner	43	28.5
Believe about prayers	48	31.8
Afraid of losing a breast	44	29.1
Fear for cancer treatment	46	30.4
Fear of partner abandonment	67	44.4
After treatment disease get worse	64	42.4

***Socio economic factors related to the delayed presentation of breast cancer***

When considering the living area, 62% (n=94) of patients belonged to rural areas. Twenty four percent of patients had more than 10 kilometers from their home to nearest medical center. Eighty six percent of study participants had therefore used public vehicles as their transport method to reach a hospital. Therefore, the study results emphasized that living in rural areas, distance from the medical center (more than 10 kilometers) and use of public transport also triggered for delayed presentation of breast cancer. Even a study conducted in the United State found that majority of patients sought medical advice late as a result of transportation problems (Lannin et al., 1998). Stapleton et al. (2011) found that majority of the Egyptian women delayed seeking medical consultation due to the long distance between their homes to the cancer center. Longer travelling time and use of public transport system may limit access to health care. Similar studies carried out in India (Ali et al., 2008) and Pakistan (Khan et al., 2015) supported this study findings.

The study results further revealed that 83% (n=125) of patients did not have family histories of breast cancer. The patients who had family histories of breast cancer were only 17.2% (n=26). However, they also delayed seeking proper medical consultation. Moreover, only 22% of patients with breast cancer stage III and IV were employed while 56% had monthly family income less than 10,000 Sri Lankan rupees. (Table 4). Thus, poverty and financial difficulties have been the causes for the delay in seeking medical treatment in the developing as well as developed countries (Anyanwu, 2008; Arndt et al., 2002). Donker et al. (2015) identified that there were two main dimensions of access to health care: physical access and economic access. Moreover, the economic access to health care also affected the seeking medical consultation for breast cancer as it was expensive (Donker et al., 2015). However, in Sri Lanka free health care facilities are available but the overcrowding and the time it takes to obtain treatments (eg. Mammography) might influence the use of such facilities.

**Table 5.** Socio economic factors related to the delayed presentation of breast cancer

<b>Socio Economic Factors</b>	<b>Frequency (n=151)</b>	<b>(%)</b>
Living in rural area	94	62.3
Transport by public vehicles	129	85.4
Monthly income below Rs. 10,000.00	54	35.8
Distance for medical center above 10 Km	37	24.5
Negligence by family members	119	78.8
Family history of breast cancer	26	17.2

## **Conclusion**

The results of the study highlighted that the lack of awareness among patients regarding the symptoms such as breast lump, nipple discharge, breast or nipple pain, breast enlargement, and nipple retraction. Early detection methods such as self-breast examination and lack of awareness about the Well Women Clinic were common perceived factors related to delayed presentation of breast cancer among women in the Teaching Hospital Kandy. The study results further emphasized that socio economic factors such as low family income, living in rural areas, use of public transport system to reach

health centres, and negative family history were common. Negative attitudes such as the fear of losing a breast, fear of partner abandonment, perceived embarrassment in exposing breasts to health care professionals, belief that the disease would get worse after treatment were contributed to delayed presentation of breast cancer. Moreover, use of indigenous and traditional medication cannot also be disregarded.

The study recommends the establishment of effective public awareness programs about breast cancer thus addressing early detection through self-breast examination and the need for seeking health care as early as possible. Furthermore, expansion of health care facilities all over the country for diagnosis and treatment of breast cancer is essential. Extending the role of nurse and allied health professionals may also be a way of strengthening the health care services related to breast cancer diagnosis and management. Moreover, establishment of mammography services and advancement of breast reconstruction techniques could minimize delayed presentation and optimize cancer treatment outcomes. This will help to increase prognosis, survival rate and improve quality of life among patients with breast cancer. Further studies on the topic should be carried out to expand and to collaborate with the present findings of this study to minimize delayed presentation of breast cancer. Ultimately this will further help to minimize morbidity and mortality associated with breast cancer in Sri Lanka.

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## Ecosystem Carbon Stock of Mangroves at the Batticaloa Lagoon, Sri Lanka

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### Abstract

Mangroves play an important role in sequestering organic carbon in tropical and subtropical coastal areas, accounting up to 15% of the total carbon deposited in coastal sediments. Sequestered organic carbon occurs both in standing plant biomass, as well as in the below ground root biomass and mangrove soils. Unavailability of quantitative data on carbon retention capacity of Sri Lankan mangrove ecosystems compelled the authors to carry out the present study with the objective of estimating the total ecosystem carbon content in mangrove eco systems in the Batticaloa lagoon, Sri Lanka.

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This is the largest lagoon situated on the east coast and the third largest brackish water system in the country. Data on vegetation structure were gathered according to the standard procedures and biomass of mangrove trees was determined by the Allometric method. Total Organic Carbon (TOC) in three depths, (0-15 cm, 16-30 cm and 31-45 cm) of mangrove soils was determined by dichromate-oxidation method followed by colorimetry. Total mangrove plant biomass was found to be 298 Mg ha<sup>-1</sup>, of which 246 Mg ha<sup>-1</sup> was in the above ground components of the plants while 52 Mg ha<sup>-1</sup> was in the below ground components. TOC embedded in biomass was calculated to be 158 Mg C ha<sup>-1</sup> out of which 131 Mg C ha<sup>-1</sup> was found to occur in above ground and 27 Mg C ha<sup>-1</sup> in below ground components. TOC in mangrove soils (up to 45 cm depth) was revealed to be 348 Mg C ha<sup>-1</sup>. The total TOC of mangrove ecosystems in the Batticaloa lagoon was calculated to be 506 Mg C ha<sup>-1</sup>. Mangrove soils that sequester 68% of the organic carbon forms the largest fraction of the mangrove carbon sink. Below ground components account for only 5% of the total pool while the above ground biomass retains five times more (26%) carbon than the root biomass. These results assist pragmatic evaluation of ecological value of mangroves and justify their conservation and management.

**Key words:** Sri Lankan mangroves; carbon sequestration; soil carbon sinks

## Introduction

Mangroves rank among the most carbon rich ecotone-ecosystems that occur along tropical and subtropical coastlines. Due to their *relatively* high primary productivity and anaerobic conditions in the inter-tidal soil/ sediment, they occupy an important role in carbon sequestration in intertidal environment (Komiyama et al., 2008; Donato et al., 2011; Hoque et al., 2011). While occupying only a small percentage (<0.1%) of earth's surface, mangroves are responsible for 10-11% of the total export of carbon to the ocean and for 8-15% of the carbon deposited in coastal sediment (Dittmar et al., 2006; Joshua et al., 2012; Jennerjahn & Ittekkot, 2002). Mangroves sequester organic carbon, in above ground plant biomass, below ground root biomass and also in soil (Alongi, 2011; Kauffman et al., 2011; World Bank, 2011). As nearly as half the biomass in trees contains carbon and large amounts of carbon are potentially stored

in mangrove forests and therefore, they may be the largest stores of carbon in coastal zones (Suratman, 2008; Perera & Amarasinghe, 2016). It is estimated that carbon sequestration capacity of global mangroves is approximately 25.5 million tons of carbon per year (Ong, 1993).

The coastline of Sri Lanka is approximately 1600 km long and a narrow intertidal belt created by micro tidal conditions with tidal amplitude less than 1 m (Wijeratne, 2007). Total estimated brackish-water area of Sri Lanka is about 15800 ha (Karunathilake, 2003) and it hosts several ecosystems including mangroves that extend over an area of 15670 ha, interspersed along the coastline (Edirisinghe et al., 2012). Mangrove vegetation in Sri Lanka comprises twenty-three (23) true mangrove species and thirty-four mangrove associated plant species (Amarasinghe & Perera, 2017).

Available knowledge on carbon sequestration capacity of tropical ecosystems in Sri Lanka is scanty. Limited records are available on the standing stock of carbon in a few man-made ecosystems in Sri Lanka, i.e 90 – 104 t ha<sup>-1</sup> in home gardens (Dissanayake et al., 2009), 63 t ha<sup>-1</sup>, carbon in soils of coconut plantations in the wet climatic zone, 54 t ha<sup>-1</sup> in the intermediate zone and 37 t ha<sup>-1</sup> in the dry zone (Chokkalingam & Vanniarachchy, 2011). A few records are available on above ground biomass of mangroves of Sri Lanka. Dayarathne & Kumara (2013) reported the above ground biomass (68.7-201.8 t ha<sup>-1</sup>) of Rekawa mangroves, and Gunawadena et al., (2016) reported the above ground biomass estimation (of mangroves located in Negombo - Muthurajawela wetland in Sri Lanka using ALOS PALSAR Images (33-155 t ha<sup>-1</sup> with overestimation of 17%). The present study therefore was conducted with the objective of quantifying the total ecosystem carbon content, including above and below ground plant component and soils of mangrove ecosystem in the Batticaloa lagoon.

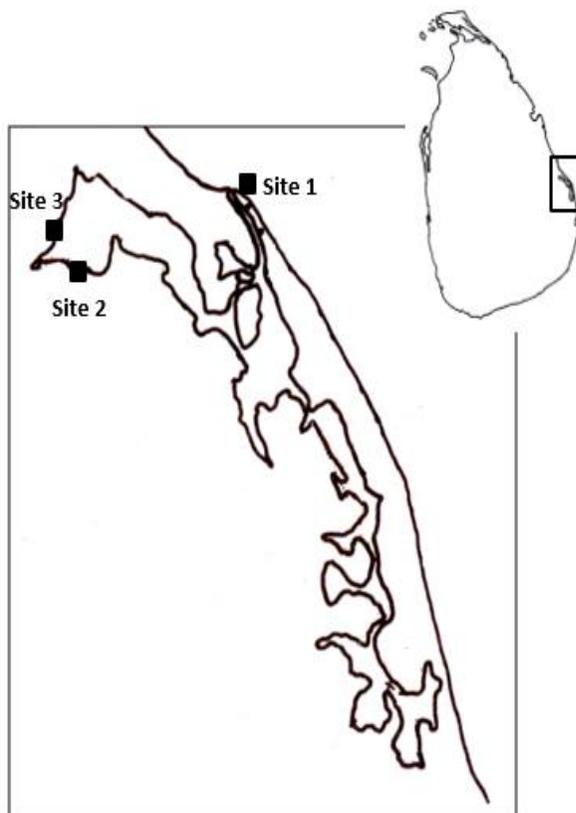
## Materials and method

### Study area and sites

Batticaloa lagoon lies between  $7^{\circ} 24'$ - $7^{\circ} 46'$  N and  $81^{\circ} 35'$ - $81^{\circ} 49'$  E, and is the largest lagoon in the east coast and the third largest brackish water system in Sri Lanka (JUGAS Ltd. (2010). This lagoon extends over 11500 ha and connects with the Indian Ocean at two locations through narrow channels. Sand bars formed due to coastal sedimentation

processes serves the lagoon-ocean connection causing changes of the

water salinity from  $0-30 \text{ mg l}^{-1}$  (Harris & Vinobaba, 2013). The mean annual temperature is  $30^{\circ} \text{ C}$  which varies from  $18^{\circ} \text{ C}$  to  $38^{\circ} \text{ C}$  while the annual rainfall varies within 864 - 3081mm with an average of 1500mm (Kotagama et al., 1989). The extent of mangrove vegetation reported from the area is approximately 1550 ha and they are restricted mostly to the northern end of the lagoon (Rajeeshan & Jayasingam, 2000). Therefore, three (3) study sites (Site 1, Site2 and Site 3) from northern part of the Batticaloa lagoon were selected for the study (Fig. 1). Minimum distance between two study sites was at least 2 km.



**Figure. 1.** Locations of study sites at Batticaloa lagoon

### Sampling Strategy

In order to gather data on mangrove vegetation structure, including biomass and Total Organic Carbon (TOC) content in mangrove soil,

10 m wide belt transects were laid perpendicular to the shoreline at randomly selected locations in the selected study sites. Length of a transect at each site was determined by the width of the mangrove area and visual heterogeneity of the mangrove vegetation. Total of five (5) transects, one at study Site 1 and two each at Sites 2 and 3 were laid. Maximum lengths of the transects were, 20m in Site 1, 30m in Site 2 and 30m in Site 3. Each transect was divided into 10 m x 10 m (100 m<sup>2</sup>) sub-plots and thus a total of twelve (12) sampling plots, within three (3) study sites were used for sampling. All mangrove trees in the plots were identified, numbered and mapped.

### **Vegetation Structure**

Standard methods were adopted to quantify the major structural variables of the mangroves stands (Cintron & Novelli, 1984, Kathiresan & Khan, 2010), i.e. species richness, tree diameter at breast height (dbh) and tree height of the mangrove stands were gathered from each study plot (100 m<sup>2</sup>) in the belt transects. Plants with a stem girth, less than 2.5 cm were excluded.

Complexity Index (CI), was calculated to determine the structural complexity of the vegetation (Holdridge et al., 1971; Kathiresan & Khan 2010; Perera et al., 2013; Perera & Amarasinghe 2016). CI was calculated using data on the number of species, stand density, basal area and height.

CI = Number of species x stand density x stand basal area x stand height x 10<sup>-5</sup>

### **Biomass and Total Organic Carbon (TOC) content in mangrove vegetation**

Allometric equations derived for individual species as well as common equations were used to determine the above ground biomass and below ground biomass of mangrove species encountered in the study plots.

The allometric equations of AGB= 0.289 (dbh)<sup>2.327</sup> and BGB= 0.100 (dbh)<sup>2.364</sup> were used to calculate the above ground biomass (AGB) and below ground biomass (BGB) of *Bruguiera gymnorhiza*. The allometric equation, AGB= 0.114 (dbh)<sup>2.523</sup>, was used to calculate the above ground biomass (AGB) of *Lumnitzera racemosa* while below ground biomass (BGB) was computed with BGB= 0.118 (dbh)<sup>2.063</sup> (Perera et al., 2012). The above ground biomass of *Rhizophora*

*mucronata* and *Avicennia marina* was calculated with  $\log_e(\text{AGB}) = 6.247 + 2.64 \log_e(\text{dbh})$  and  $\log_e(\text{AGB}) = 5.551 + 2.153 \log_e(\text{dbh})$  respectively (Amarasinghe & Balasubramaniam, 1992). The biomass of other species in the sample plots were calculated using common equations, i.e.  $\text{AGB} = 0.251 \rho \text{ dbh}^{2.46}$  and  $\text{BGB} = 0.199 \rho 0.899 \text{ dbh}^{2.46}$  ( $\rho$  – density of wood) (Komiya et al., 2005). Standing stock of biomass values were then converted to the TOC values with the percentage TOC content in biomass of each plant component of mangrove species (Perera & Amarasinghe, 2016).

### **Total Organic Carbon (TOC) content in mangrove soil**

A split core sampler/auger 77801 (2" x12") was used to collect soil samples. Soil samples were taken from a minimum of five randomly selected sites in each study plot (100 m<sup>2</sup>). Samples were collected from depths of 0 – 15cm, 16 – 30cm and 31 – 45cm. Composite soil samples were prepared for each depth. Soil samples were air-dried, and oven dried at 60°C for constant weight.

### **Chemical analysis**

Total Organic Carbon (TOC) content in composite soil samples was determined using the standard wet dichromate oxidation technique, without external procedure (Anderson and Ingram, 1998; Schumacher, 2002). K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> Solution was used to oxidize the TOC in acid medium. The amount of oxidized carbon in the sample was measured by determining the number of chromic ions produced during oxidation. Produced chromic ion concentration was determined using UV-visible spectrophotometer (Spectro UV-VIS Double Beam UVD-3000) at 600 nm absorbance.

Because of the incomplete oxidation of organic carbon and partially digest organic carbon in to elemental carbon forms, a correction factor was applied to elevate the accuracy of the results through adjusting the organic carbon recovery. As mean oxidation factor, 0.74 was used for the purpose.

$$\% \text{ organic carbon} = (K \times 0.1) / (W \times 0.74)$$

K = corrected concentration; W = Weight of the sample

A standard curve was plotted between absorbance and chromic ion concentration and it was used to obtain the carbon content in soil samples and in the blanks. The mean blank value was subtracted from the unknowns, which used as the value of corrected

concentration, (K). The bulk density of soils in three depths (0 – 15cm, 16 – 30cm and 31 – 45cm) at the Batticaloa mangrove areas was determined with standard methods (Anderson & Ingram, 1998).

## Results

### Mangrove vegetation structure

A statistically significant difference was not observed between the basic vegetation structural data gathered from sub plots in the study sites and therefore, they were pooled to analyze the structure of mangrove vegetation in the Batticaloa lagoon.

Relatively high stand density (4754 trees/ha) and low species composition were revealed in the mangrove ecosystems in the Batticaloa lagoon. Only three to four true mangrove species were encountered in the subplots (100 m<sup>2</sup>) were used for the study. *Excoecaria agallocha* (3470 trees/ha) and *Rhizophora apiculata* (1054 trees/ha) were the most abundant mangrove species in the area (Table 1). *E. agallocha* recorded the highest basal area and the tree height among other species found in the area.

Sampling area		Species relative frequency	Stand density (per ha)	Mean dbh (cm)	Basal area (m <sup>2</sup> ha <sup>-1</sup> )	Mean height (m)	Complexity index
Site 1	Transect 1	EA(1%); RA(98%); Other(1%)	9300 ±1150	10.12 (2.0-20.5)	45.62	10.5 (6.5-13.5)	47.34
Site 2	Transect 2	EA(99%); Other(1%)	4350 ±510	6.68 (2.0-22.0)	24.24	4.83 (2.0-9.0)	11.77
	Transect 3	EA(79%); RA(20%); Other(1%)	2200 ±260	8.00 (1.6-35.0)	22.30	7.89 (2.0-11.0)	14.76
Site 3	Transect 4	AM(8%); EA(85%); RA(7%)	5166 ±630	7.95 (1.8-32.0)	34.35	6.36 (2.5-11.0)	41.82
	Transect 5	AM(5%); EA(92%); RA(3%)	4800 ±545	7.59 (3.0-43.0)	32.27	5.31 (2.5- 9.5)	19.01
Mean for entire study area		EA(73%); RA(22%); AM(4%); Other(1%)	4754 ±590	8.14 (1.8-43.0)	30.01	6.6 (2.0-13.5)	27.52

**Table 1.** Vegetation structural variables recorded from the study sites at the Batticaloa lagoon

AM- *Avicennia marina*, EA- *Excoecaria agallocha*, LR- *Lumnitzera racemosa*, RA- *Rhizophora apiculata*

\*The mean follows standard error (±); Range of the values are presented within parentheses

### Biomass and Total Organic Carbon (TOC) content

A statistically significant difference was not observed ( $p>0.05$ ) in the biomass and TOC values recorded from the study plots in the three study sites. Therefore, the data were pooled to calculate the mean values for biomass and TOC of the mangrove plants in the Batticaloa lagoon (Table 2).

**Table 2.** Mangrove biomass and Total Organic Carbon (TOC) content (above and below ground) values recorded in the study sites at the Batticaloa lagoon

Sampling area	Biomass (Mg ha <sup>-1</sup> )			Total organic carbon (TOC) content (Mg C ha <sup>-1</sup> )		
	Above ground	Below ground	Total	Above ground	Below ground	Total
<b>Study Site 1</b>	346.49 ±2.95	73.86 ±0.55	420.35 ±3.56	193.93 ±2.33	40.02 ±0.36	233.95 ±2.68
<b>Study Site 2</b>	154.16 ±1.56	33.08 ±0.26	187.24 ±1.83	78.10 ±0.51	16.19 ±0.20	94.29 ±0.81
<b>Study Site 3</b>	238.68 ±2.43	49.87 ±0.34	288.55 ±2.76	122.78 ±1.70	24.69 ±0.23	147.47 ±1.94
<b>Mean for entire study area</b>	246.44 ±2.03	52.27 ±0.33	298.71 ±2.37	131.60 ±1.62	26.96 ±0.26	158.57 ±1.87

\*The mean follows standard error ( $\pm$ )

### Total Organic Carbon (TOC) content in mangrove soil

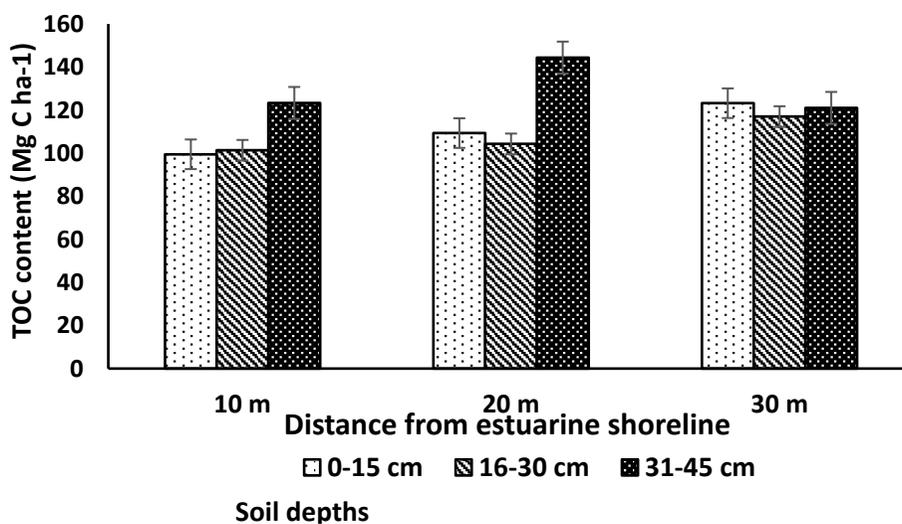
The highest values for the percentage TOC content in mangrove soil (5.55-7.30; mean=6.10) was recorded at 16-30 cm depth layer and followed by 31-45 cm depth layer (5.91-5.88; mean=5.89). The lowest percentage values (4.86-5.80; mean=5.26) for TOC was in the top soil layer (0-15 cm depth). Summary of the TOC data of the mangrove soils in the Batticaloa lagoon is presented in Table 3.

**Table 3.** Summary of the Total Organic Carbon (TOC) distributed among the different depth of mangrove soils at the Batticaloa lagoon

	Depth 1 (0-15 cm)	Depth 2 (16-30 cm)	Depth 3 (31-45 cm)
% TOC	5.26 ±0.50	6.10 ±0.52	5.89 ±0.43
Bulk density	1.37 ±0.02	1.30 ±0.02	1.36 ±0.02
TOC weight (Mg ha <sup>-1</sup> )	108.06 ±10.07	119.35 ±10.46	120.42 ±8.56

\*The mean follows standard error (±)

The lowest values of TOC contents (99.50 -123.33 Mg C ha<sup>-1</sup>) were recorded at first 10m zone from estuarine waterfront. Over-all TOC content revealed increased with estuarine shoreline to landwards (Fig. 2).

**Figure 2.** TOC contents of mangrove soil along the water-land gradient.

The TOC stock retained by the mangrove ecosystem was 506.40Mg C ha<sup>-1</sup>. Soil contained 70% of the TOC stock while 25% was in above ground and 5% in the below ground components of mangrove plants (Table 4).

**Table 4.** Calculated Total Organic Carbon (TOC) content in mangrove ecosystem at the Batticaloa lagoon

TOC in Mangrove plants (Mg C ha <sup>-1</sup> )	Above ground components	131.60 ±1.62 (25.98%)
	Below ground components (roots)	26.96 ±0.26 (5.31%)
	Total	158.57 ±1.87 (31.30%)
TOC in Mangrove soil (Mg C ha <sup>-1</sup> )		347.83 ±33.80 (68.68%)
Total (Mg C ha <sup>-1</sup> )		506.40 ±36.04

\*Standard error is in the parentheses

## Discussion

Contrary to the common occurrence of *Rhizophora mucronata* and *Avicennia marina* in most Sri Lankan mangrove ecosystems in the dry zone coastal regions and mangroves of the Batticaloa lagoon are dominated by *Rhizophora apiculata* and *Excoecaria agallocha* which are often found inter-tidal areas of low salinity (Table 1). This may be due to the differences in micro climatic and environmental circumstances prevailing in the Batticaloa lagoon, especially with respect to soil salinity (Perera et al., 2013). Mangrove communities often exhibit distinct patterns of species distribution performance efficiencies depending on tolerance levels in each plant species to environmental conditions, especially soil salinity and anoxic conditions caused by inundation regimes (Joshi & Ghose 2003, Alongi, 2009). Some species such as *A. marina* do not grow in fresh water and may be considered as an obligate halophyte. High salinity tolerance of *A. marina* has been reported to possess successive of cambia that form internal phloem tissues which can store water and also repair embolism through formation of new vascular cells (Roberts et al, 2011) Others, such as *E. agallocha*, survive well in fresh water and may not have obligatory requirement for salt beyond trace amounts (Clough, 1992). Under natural conditions, mangroves exhibit clear tolerance differences among species. Based on the reports of salinity tolerance levels of mangrove species (Clough, 1992; Joshi & Ghose 2003; Perera et al., 2013), it was revealed that most of

the low salt tolerance species dominate the Batticaloa mangrove ecosystem.

Estimates of standard biomass both in above and below ground components provide insights into carbon allocation in plants, which is a vital information regarding local as well as regional carbon accounting or sequestration (Kairo et al., 2008). Total biomass in plants of mangrove ecosystem in the Batticaloa lagoon was estimated as 298.71 Mg ha<sup>-1</sup>, out of which 246.44 Mg ha<sup>-1</sup> was in above ground and 52.27 Mg ha<sup>-1</sup> in below ground components. The amount of Total Organic Carbon (TOC) content embedded in plant biomass was calculated to be 158.57 Mg C ha<sup>-1</sup> out of which 131.60 Mg C ha<sup>-1</sup> was in the above ground and 26.96 Mg C ha<sup>-1</sup> in the belowground parts of plants (Table 2). The total standing biomass (298.71 Mg ha<sup>-1</sup>) of mangrove ecosystems in the Batticaloa lagoon therefore is greater than that in the Negombo estuary (163.72 Mg ha<sup>-1</sup>) located in the wet zone (Perera & Amarasinghe, 2016) and that in the Rekawa lagoon (62.4 - 201.8 Mg ha<sup>-1</sup>) situated in the intermediate climatic zone (Dayarathne & Kumara, 2013). Although some mangroves around the Batticaloa lagoon are destroyed for anthropogenic reasons, the areas investigated in the present study were minimally disturbed (particularly the Sites 2 and 3) due to their remote location where the human population density is low. Remote location with poor accessibility and low human density may have saved these mangroves and their carbon sequestration capacity unlike those in the wet and intermediate zones that are located close to urbanized coastal centers.

Although above ground mangrove biomass has been studied during the past few decades (Kusmana et al., 1992; Ross et al., 2001; Coronado-Molina et al., 2004; Amarasinghe & Balasubramaniam, 1992), studies on mangrove biomass which is below ground are scanty (Komiyama et al., 2008; Pongparn, 2003; Comley & McGuinness, 2005). Considering the available records of mangrove above and below ground biomass in tropical and subtropical regions, the highest above ground biomass (460 t/ha) has been recorded for *R. apiculata* dominated mangrove forests (cultivated) in Matang, Malaysia (Putz & Chan, 1986), and the lowest (40.7 t/ha) for mangroves of East Sumatra, Indonesia which features similar species (Kusmana et al., 1992). On average, above ground biomass of mangrove values range between 280 t/ha (from Southern Ranong,

Thailand) (Tamai, et al., 1986) and 108 t/ha (from Okinawa, Japan) (Suzuki & Tagawa, 1983). The above ground biomass of mangroves in the Batticaloa lagoon (246.44 Mg ha<sup>-1</sup>), can therefore be ranked relatively high among other published reports on mangrove areas in the Asian region.

Below ground biomass (BGB) calculated for mangrove ecosystems in the Batticaloa lagoon (52.27 Mg ha<sup>-1</sup>) falls in between the highest BGB estimated for mangroves in the Southern Ranong, Thailand (272.9 Mg ha<sup>-1</sup>) and the lowest recorded from Southern Peng-nag (28.0 Mg ha<sup>-1</sup>) in the same country (Komiya, et al., 2008; Pongpan, 2003).

According to findings of the present study, total biomass (above and below-the-ground) in the Batticaloa mangroves range between 187 – 420 Mg ha<sup>-1</sup> with an average of 259 Mg ha<sup>-1</sup> which can be considered relatively a high biomass value for a tropical ecosystem. Pattern of biomass distribution in mangroves throughout the tropics indicate that higher values occur at lower latitudes (Twilley et al, 1992). The maximum potential biomass is found in mangrove areas located between 10° and 35° north and south and it is about 100 and 400 t ha<sup>-1</sup> and solar energy represents a major constraint on the distribution of mangrove biomass across the latitudes (Twilley et al, 1992).

The average content of Total Organic Carbon (TOC) in mangrove with soils up to a depth of 45 cm was estimated to be 348Mg C ha<sup>-1</sup>. The general pattern of distribution of TOC in tropical forests has been reported to be a decreasing trend with increasing depth (Grace et al, 2006; Ceron-Breton et al., 2011; Banerjee, et al., 2013). A reverse trend was observed in mangroves in the Batticaloa lagoon where the %TOC increases with soil depth (Table 3). This may be due to the sandy sediments in the mangrove forest floor, which accounts for relatively a high bulk density values (1.3 g cm<sup>-3</sup>). Levels of TOC content in mangrove soils were recorded higher than that was recorded from the soils of inland forest systems (Donato et al., 2011). The Present study revealed that TOC values of the mangrove soils in the Batticaloa lagoon, 348 Mg C ha<sup>-1</sup>, which is twice higher than the TOC recorded for soils of tropical savanna forests, (146 – 198 Mg C ha<sup>-1</sup>) at Yap and Palau islands in Pacific Ocean (Donato et al., 2012) and Brazil, 90 – 160 Mg C ha<sup>-1</sup>(Moreno & Calderon, 2011).

## Conclusion

Mangrove ecosystems in the Batticaloa lagoon which have the capacity to sequester on average, 506 Mg C ha<sup>-1</sup> of TOC therefore can be ranked superior among the other mangrove ecosystems in the region such as those in Okinawa, Japan of which the carbon sink capacity ranges between 57 – 822 Mg C ha<sup>-1</sup> (Khan et al., 2009), and Campeche, Mexico ranges 12 – 222 Mg C ha<sup>-1</sup> (Cerno-Breton et al., 2011). Findings of the present study therefore contribute to the current knowledge base on functional capacities of Sri Lankan mangroves, and therefore encourages rational decision making on conservation and management of mangrove areas for their ecological services including their carbon sequestration function and contribution to mitigate anticipated climatic changes. They also could contribute to make more accurate estimations on stocks of sequestered carbon required for carbon trading purposes such as those initiated by the United Nation's REDD+ (Reducing Emissions from Deforestation and Forest Degradation, Conservation and Enhancement of Carbon stocks, and Sustainable Management of Forest) facilities.

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## Structural Assessment and Restoration of the NeelagiriMaha Seya in Ampara, Sri Lanka

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### Abstract

NeelagiriMaha Seya, constructed in the 2<sup>nd</sup> Century BC, is a colossal ruined stupa, situated in the woods of the Lahugala wildlife sanctuary in the Ampara district of the Eastern province, Sri Lanka. The stupa has a circumference of 182 m (600') and a height of 22.6 m (74'). Presently, one side of the stupa has collapsed and some vertical cracks are visible on the eastern side of lower dome section of the stupa. Therefore, it is essential to carry out proper investigation on the current condition of the stupa before undertaking any major restoration work to restore the stupa to its original height. With this

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objective, a series of experimental testing and numerical modeling were performed. The foundation of the stupa was assessed using the Ground Penetration Radar (GPR) method. According to the GPR measurements, the stupa spreads 2.87 m away from the basal rings to a depth of 3 m from the existing ground level. It is apparent from GPR data, there exists gravel type rock below 3 m level from the existing ground and the stupa rests on matt gravel layer. Material properties of the ancient bricks of the stupa were evaluated with adequate laboratory testing. Test results showed that ancient bricks of the Neelagiri stupa have higher capacity than the modern bricks. Numerical analysis of the stupa was carried out using the general finite element software package SAP2000 to assess the stresses developed in the stupa due to its self-weight. The results showed that the stresses developed within the existing stupa due to its self-weight were well below the compressive strength and the tensile strength of the ancient bricks. Further, the study suggests two alternative shapes (bubble and paddy heap shapes) for completing the stupa restoration. A suitable shape is proposed for the restoration and the different restoration options have been analyzed with respect to structural performance along with the existing conditions.

**Key words:** Stupas, Ancient Bricks, Mechanical Properties, Ground Penetration Radar, Finite Element Analysis

## **Introduction**

Ancient stupas in Sri Lanka are solid structures, mostly composed of burnt clay bricks. Construction of stupas began in the 3<sup>rd</sup> Century BCE and lasted until the 13<sup>th</sup> Century CE. During this period, some stupas, such as the Jethavana attained gigantic proportions, making them the largest brick structures in the world (Ranaweera 1998). At the turn of the 19<sup>th</sup> Century, all the ancient stupas were in ruins, covered with thick vegetation. Initial rehabilitation of these stupas was attempted in haphazard ways, but presently the modern civil engineering principles along with archaeological heritage management are being applied for the conservation and restoration of these historical structures (Ranaweera & Silva 2006; Silva 2002).

NeelagiriMaha Seya, constructed in the 2<sup>nd</sup> Century BCE, is a colossal ruined stupa, situated in the woods of the Lahugala wildlife sanctuary of the Ampara district of the Eastern province. The stupa had been abandoned for nearly 1200 years. It has a circumference of 182 m (600') and a height of 22.6 m (74') in its current status. Some

restoration work was started in 1960 and later on had to be abandoned due to the civil war. The structure has been opened only after 2010 and restoration work was begun in 2011. Fig. 1(a) shows a view at its current status.



**Figure 1.** Two views of the stupa: (a) after the removal of vegetation cover (b) a crack formed in the dome of the stupa

One side of the stupa has collapsed and some vertical cracks are presently visible on lower dome section of the stupa, as shown in Fig. 1(b). Therefore, it is essential to carry out proper investigation on the current condition of the stupa before any major restoration work. This paper aims to investigate the present condition of the stupa, with specific focus on experimental testing on construction materials used in the stupa construction followed by numerical modeling of the stupa to aid its restoration work.

## **Methodology**

Site visits and information obtained from the literature review revealed that the main construction material used for the stupa is burnt clay bricks. Old bricks used for the construction of the stupa by the ancient engineers differ from modern bricks in sizes. In this regard, there were four different sizes of bricks which are comparatively larger than modern engineering bricks. The details of these four brick types are shown in Table 1. A close analysis revealed that these brick types were used in random without a distinct pattern. However, the usage of type IV bricks was rare. The mortar layers in between bricks were similar to the other stupas in Sri Lanka. Further, brick layering did not follow specific rules.

**Table 1.** Dimensions of different types of bricks

<b>Brick Type</b>	<b>Weight (kg)</b>	<b>Length (L)/(mm)</b>	<b>Breadth (W)/(mm)</b>	<b>Thickness (H)/(mm)</b>
I	8.709	290	220	85
II	9.881	420	220	78
III	9.461	295	260	83
IV	8.182	235	165	113

### ***Experimental Testing of Bricks***

The mechanical properties of brick samples were determined using non-destructive testing methods. In this context, portable ultrasonic non-destructive digital indicating tester (PUNDIT) instrument and resonance frequency instrument were used. In PUNDIT instrument, determination of elastic modulus is based on the pulse velocity. Table 2 shows the results obtained on pulse velocity. Thereafter, elastic modulus and the Poisson's ratio were determined for four brick types as shown in Table 2.

**Table 2.** Measurements of PUNDIT instrument for different types of bricks

<b>Brick Type</b>	<b>Path Length (L)/(in)</b>	<b>Transit Time (<math>\mu</math>s)</b>	<b>Pulse Velocity (V)km/s</b>	<b>Elastic Modulus (kN/mm<sup>2</sup>)</b>	<b>Poisson's Ratio</b>
I	4.25	63.80	1.69	10.05	0.25
II	4.25	54.85	1.97	11.00	0.24
III	4.25	55.47	1.98	11.00	0.20
IV	6.25	99.25	1.6	9.50	0.25

Compressive strength of bricks was measured through a compressive testing machine. Water absorption testing of bricks was done after immersing brick samples for 24 hours and measuring the weight gain. Dry density of bricks was measured using oven dried brick samples. The results obtained are given in Table 3.

**Table 3.** Mechanical properties of different types of bricks

<b>Brick Type</b>	<b>Water Absorption (%)</b>	<b>Dry Density/ (kg/m<sup>3</sup>)</b>	<b>Compressive Strength (MPa)</b>
I	8	1615.74	3.003
II	9.1	1315.98	8.581
III	9.6	1423.97	9.654
IV	9.6	1703.80	4.291

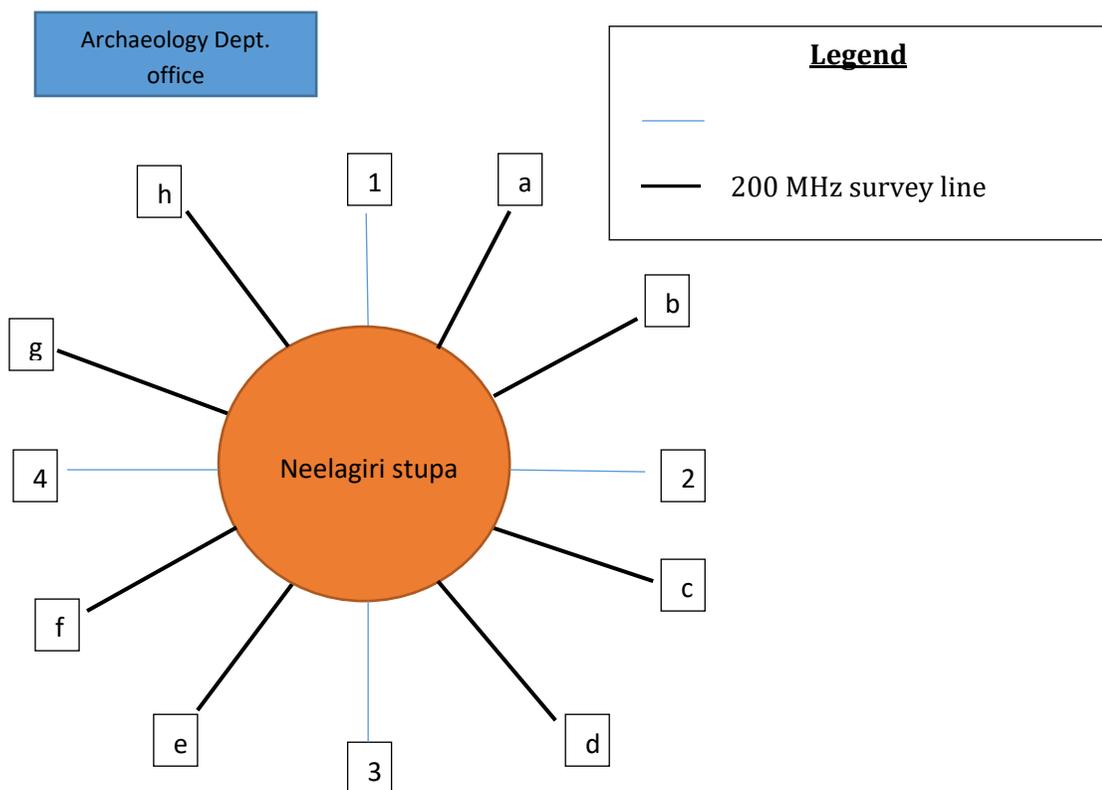
Table 4 shows the elastic modulus and Poisson’s ratio of ancient bricks from other stupas with the Neelagiri stupa. The compressive strength of bricks from the Neelagiri stupa is almost five times as strong as modern bricks.

**Table 4.** Comparison of mechanical properties of different stupas

<b>Brick Type</b>	<b>Elastic Modulus (kN/mm<sup>2</sup>)</b>	<b>Poisson's Ratio</b>
Jethavanaseya (Ranaweera 1998)	4.5	0.25
Sandagiriseya (Ranaweera 1998)	9.79	0.27
Neelagiriseya	10.53	0.24
Modern brick	1.92	0.21

**Ground Penetration Radar**

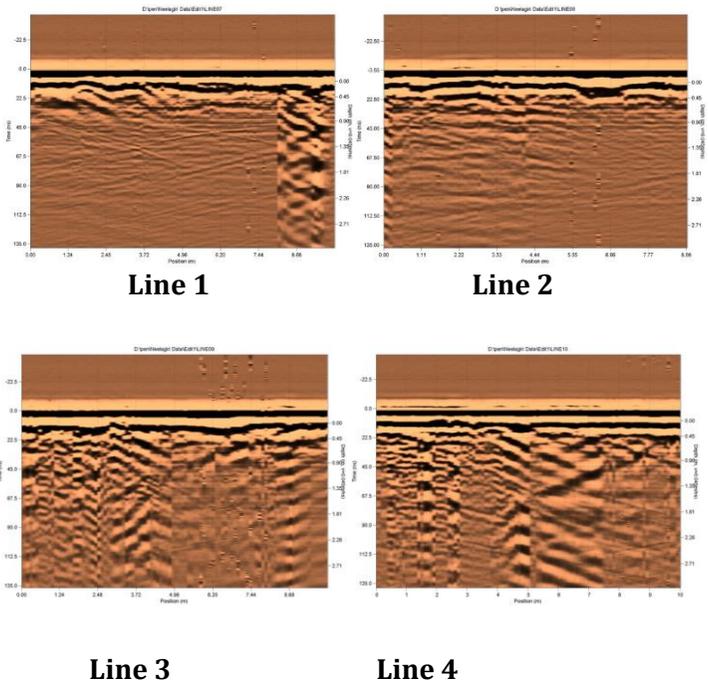
The purpose of ground penetration radar is to determine the foundation work of the stupa. Twelve observation lines were surveyed around the Neelagiri stupa, from the basal ring, about 30 m spanning as shown in Fig. 2. In lines 1, 2, 3 and 4, 200 MHz antenna was used while lines a, b, c, d, e, f, g and h, 500 MHz antenna was used. The procedure of Ground Penetration Radar use is given by Dojack, 2012.



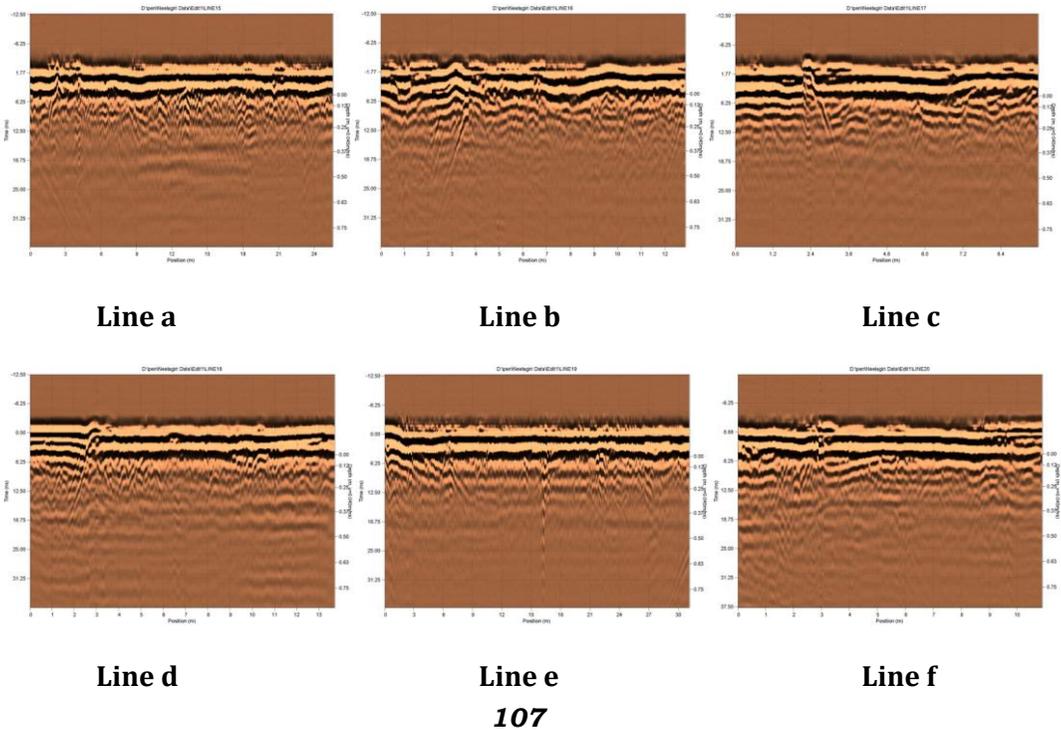
**Figure 2.** Layout of survey lines for ground penetration radar

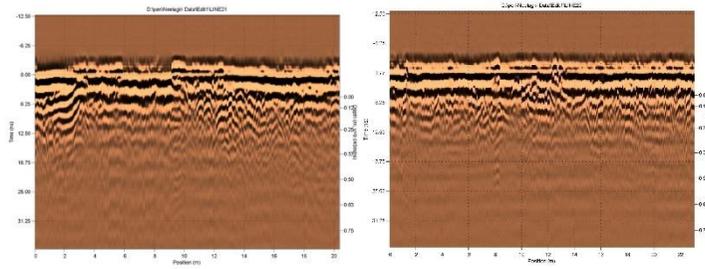
### **GPR Results**

Figures 3 and 4 show the results of GPR machine for each selected line. However, it is difficult to identify the underground data straight from frequency data. Therefore, the *EKKO View Deluxe* software was used to analyse reflection data removing unnecessary noise waves. Fig. 3 shows 200 MHz survey line results of GPR machine. 200 MHz GPR is capable of surveying the depth of 5 m to 10 m. Fig. 4 shows the 500 MHz survey line results of GPR machine. 500 MHz GPR is capable of surveying of 0 m to 5 m depth. It is more suitable for 2.5 m depth.



**Figure 3.**The 200 MHz survey line results of GPR machine





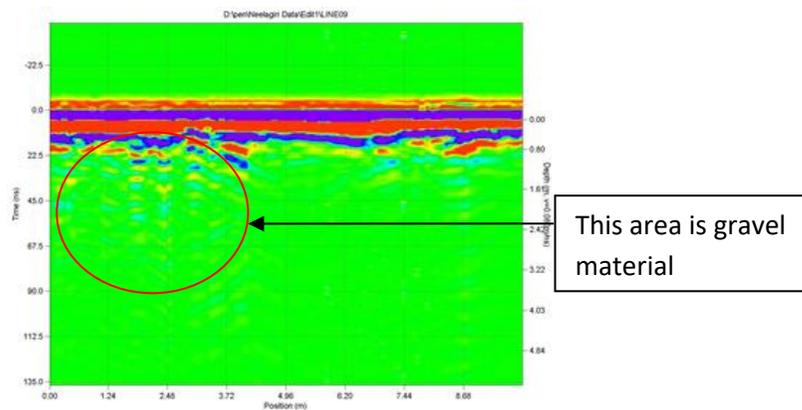
Line g

Line h

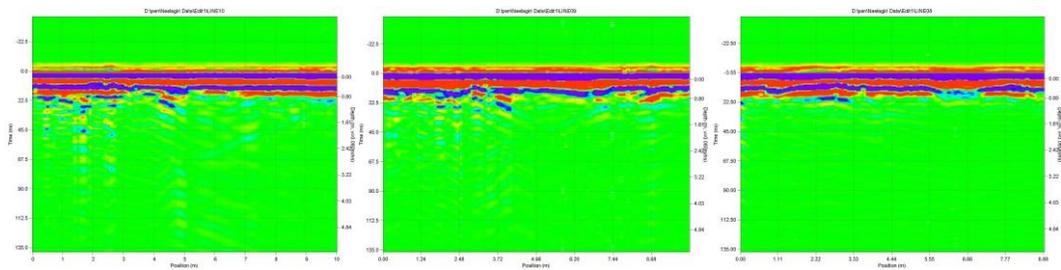
**Figure 4.** The 500 MHz survey line results of GPR machine

**The Analysis of GPR Data**

The obtained results are shown in Figures 5, 6 and 7.



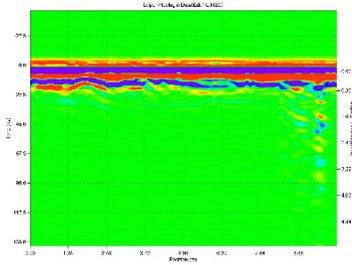
**Figure 5.** The analyzed GPR 200 MHz survey line 1 around the stupa



Line 1

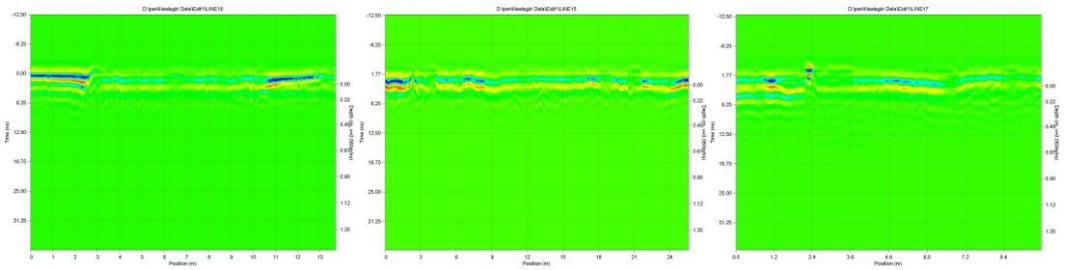
Line 2

Line 3



Line 4

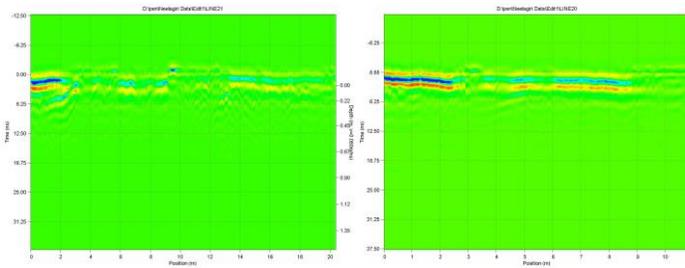
**Figures 6.** The all-analyzed GPR 200 MHz survey lines around thestupa.



Line a

Line b

Line c



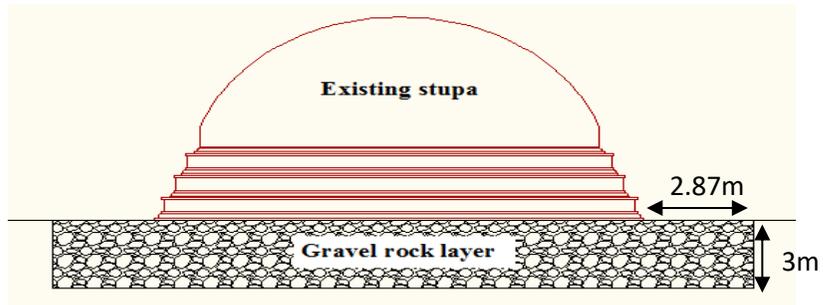
Line d

Line e

**Figures 7.** The all-analyzed GPR 500 MHz survey lines around thestupa

The data collected clearly showed the foundation structure of the stupa. The resulting survey information facilitated the identification of the type of materials used for the foundation of the stupa. The foundation of the stupa is spread around for the average distance of 2.87 m from basal rings (Fig. 8). According to the survey (based on the velocity of the radar through materials), it is apparent that there

is a clay wet soil at the top layer and gravel materials at the bottom layer up to the bed rock. This gravel layer is around 3 m deep.



**Figure 8.** Mapping the extent and location of the foundation around the stupa

The observations of results do not indicate the deepest point in the bed rock because it was difficult to take the readings in continuously due to the presence of water locations on the survey lines.

### ***Full Geometry of the Stupa***

During excavation, small stupa structures were found in the site. Those stupas may symbolize the original shape of the stupa. When those stupas were examined, it was identified that the bubble shape and the paddy-heap shape are more common than the other shapes. However, there is no information about the actual shape of the ancient Neelagiri stupa. Therefore, bubble and paddy-heap shapes were considered for the restoration works.

### ***Height Proportion of the Stupa***

The present Neelagiri stupa is only about one third of its complete height according to the studies of the archaeologists (Somadeva 2012). Therefore, more than about two third area of the collapsed stupa is to be restored with a complete dome and the superstructure. Some of the other ancient stupas were closely examined to identify the height of elements with respect to the diameter and the shape of the dome. Therefore, in the suggested restoration design, the height was compared with Mirisawetiya (bubble shape) and Jethavana (paddy-heap shape) stupas according to the diameter of the Neelagiri stupa and its shape.

**Table 5.** Height details of Jethavana and Mirisawetiya stupa

Components	Jethavana* (paddy-heap shape) (m)	Mirisawetiya** (bubble shape) (m)
Diameter	102	53.5
Three pesavas	3.69	3.29
Dome	41.76	23.99
Square chamber	11.79	6.86
Dewathakotuwa	9.45	4.42
Koth karalla	22.25	18.59
Total height without kotha	88.94	57.15

\*The dimensions are according to the source (Gamalath 1997)

\*\*The dimensions are according to the drawing, Dept. of Archaeology

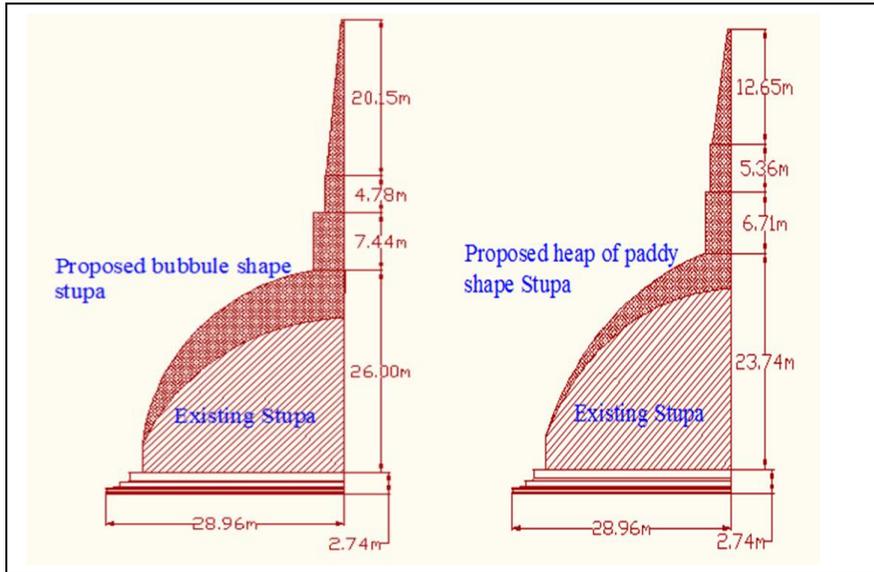
**Table 6.** Height details of the Neelagiri stupa alongside the Jethavana and Mirisawetiya

Components	Height according to Jethavana (paddy-heap shape ) (m)	Height according to Mirisawetiya (bubble shape) (m)
Three pesavas	2.1	3.6
Dome	23.7	26.0
Square chamber	6.7	7.4
Dewathakotuwa	5.4	4.8
Koth karalla	12.7	20.1
Total height without kotha	50.6	62.0

According to the diameter of Neelagiri stupa, the above height details were calculated using the Jethavana and Mirisawetiya stupas as in Table 6. Based on the dimensions obtained, two alternative models

were developed with two different shapes considering the shape as bubble and paddy-heap. The structure was modeled as solid brick structure. The proposed two alternatives are as follows:

- a) **Alternative I** : Bubble-shape solid brick structure [Figure 9 (a)]
- b) **Alternative II** :Paddy-heap shape solid brick structure [Figure 9 (b)]



**Figure 9.** (a) Alternative I and (b) Alternative II

The proposed construction could be achieved through old bricks or new bricks. Therefore, there are four different options which have to be analyzed separately in addition to the existing stupa.

## Finite Element Analysis

### **Materials Properties for Finite Element Models**

Among the different restoration options suggested for the Neelagiri stupa which were discussed in detail in above, a solid brick structure is proposed to complete the existing stupa. The finite element analysis of this solid superstructure is to be carried out by using the material properties of presently available good quality wire-cut bricks as well as old bricks. The material properties, elastic modulus, compressive strength and tensile strength of these bricks were obtained by the same test methods described for the existing old brick in above section. Table 7 shows the results obtained for the elastic modulus,

and compressive strength of the wire-cut brick respectively. These mechanical properties were used during finite element modeling.

**Table 7.** Material properties of modern and Neelagiri stupa bricks

<b>Properties</b>	<b>Modern bricks</b>	<b>Neelagiri bricks</b>	<b>stupa</b>
Dry density (kNm <sup>-3</sup> )	17.0	17.46	
Wet density(kNm <sup>-3</sup> )	19.6	19.04	
Elastic modulus (GPa)	2.3	10.0	
Poisson's ratio	0.21	0.24	
Compressive strength (MPa)	3.60	6.38	
Tensile strength (MPa)*	0.31	0.55*	
Thermal coefficient*	$5.5 \times 10^{-6}$	$5.5 \times 10^{-6}$ *	

\* *Data extracted same era stupa (Yudaganawadagoba)*

**Model used for the Analysis**

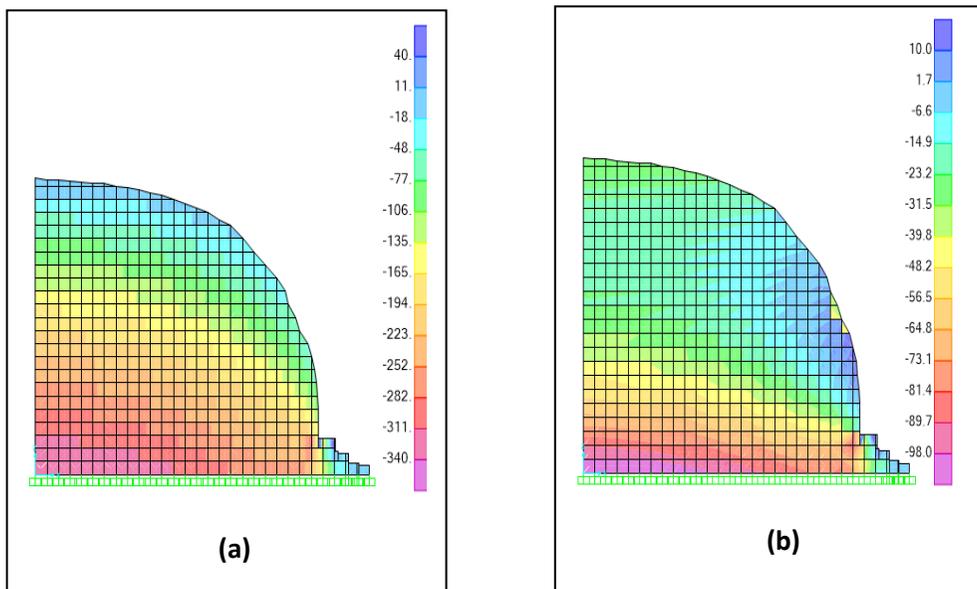
The stupa was analyzed using an axisymmetric model by considering a half of the stupa for each alternative. In this case, the stupa was considered to be symmetric about the vertical axis. The geometric models used in the analysis for each alternative are shown in Fig. 9 (a) and 9 (b) respectively. These two models were analyzed using SAP2000. The model was also analyzed for self-weight.

**Model 1 (Old Brick Work, Existing Condition)**

From the direct stress contours (Fig. 10a), it can be noted that under self-weight, the stupa experiences compressive stresses and it gradually increases from top to bottom. A compressive stress variation of 0 kPa to 339 kPa can be seen for the vertical stress in the stupa. Majority of the stresses are compressive. A tensile stress region can be noted in the basal rings area but the magnitudes of these tensile stresses are in the range of 0 kPa to 304 kPa. There are no tensile stresses at the outer surface of the dome. A sudden decrease in stress can be seen at the edges of the basal rings. This behavior could be attributed to the fact that these places are sharp corners. A detailed analysis of stresses at each region of the stupa is given below. The maximum compressive stress occurs at the centre of the foundation level and has a magnitude of 339 kPa almost 18 times

less than the allowable compressive strength of Neelagiri stupa's old bricks which has a value of 6380 kPa.

The hoop stress contours (Fig. 10b) also show a majority of compressive stresses and they too tend to increase from top to bottom. As in other stress contours, a high concentration of stresses can be seen at sharp corners. The tensile hoop stresses can be noted at the top of the dome and basal rings areas and, the magnitudes of these tensile hoop stresses are in the range of 0 kPa to 97 kPa. The highest tensile hoop stress occurs at the corner where the dome meets the basal rings.



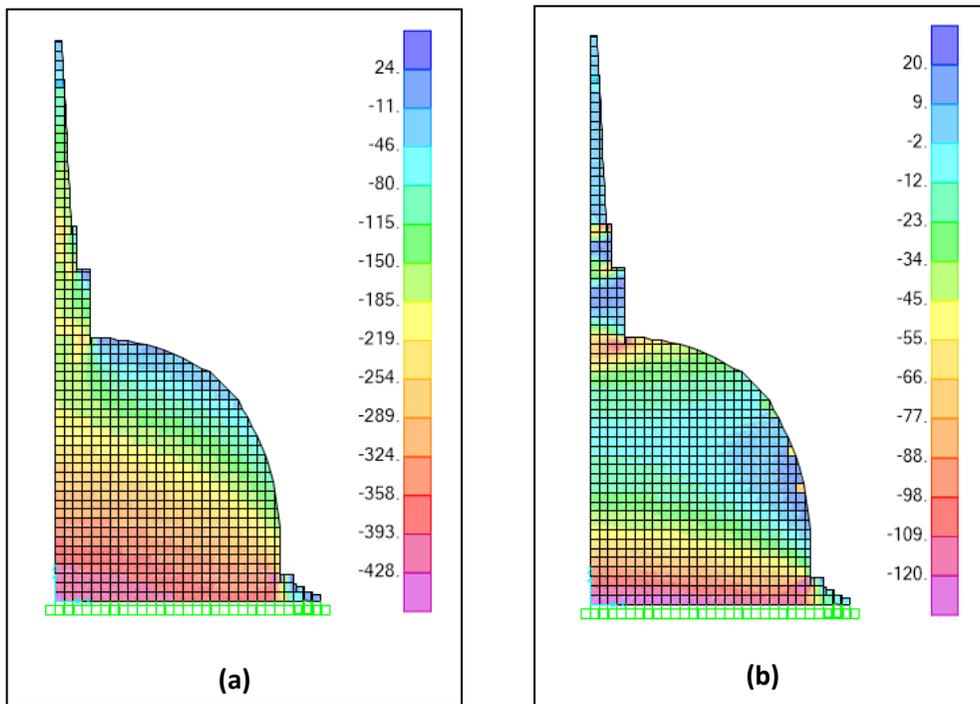
**Figure 10.** (a) vertical and (b) hoop stress contours ( $\text{kN/m}^2$ ) for the existing stupa model

### ***Model 2(Old Brick Work, Proposed Bubble Shape)***

A compressive stress variation (Fig. 11a) of 0 kPa to 428 kPa can be seen for the vertical stress in the stupa. Majority of the stresses are compressive here. Another variation which can be noted is the stress concentration at the corners. Places where the square chamber meets the dome and where the dome meets the basal rings have high tensile stress concentrations compared to the surrounding areas. In the model created with the Neelagiri stupa bricks, it can be noted, that under self-weight most parts of the stupa are under compression and this compressive stress gradually increases from top to bottom. The

maximum compressive stress occurs at the centre at the foundation level and its value is 428 kPa. At the outer surface of the dome no tensile stresses could be noted.

The hoop stress contours (Fig. 11b) also show a majority of compressive stresses and they too tend to increase from top to bottom. As in other stress contours a high concentration of stresses can be seen at sharp corners. The tensile hoop stress can be noted at the square chamber area, top of the dome and basal rings area and the magnitudes of these tensile hoop stresses are in the range of 0 kPa to 149 kPa. The highest tensile hoop stress occurs at the corner where the dome meets the basal rings.



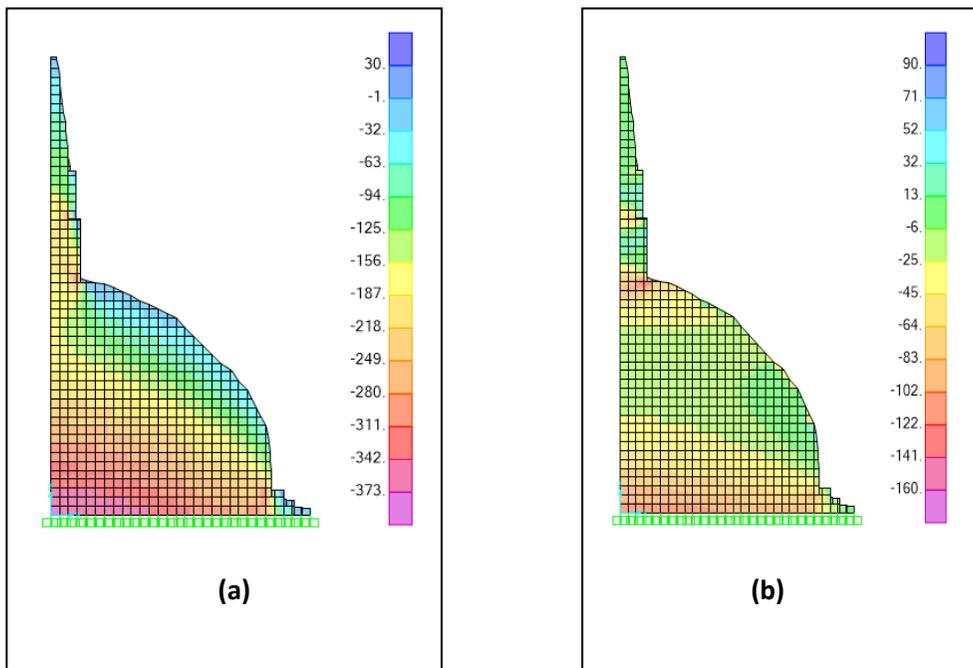
**Figure 11.** (a) vertical and (b) hoop stress contours (kN/m<sup>2</sup>) for the bubble shape model

### **Model 3 (Old Brick Work, Proposed Paddy-Heap Shape)**

From the direct stress contours (Fig. 12a) it can be noted that, under self-weight, the stupa is under compression and this compressive stress gradually increases from top to bottom. A compressive stress variation of 0 kPa to 373 kPa can be seen for the vertical stress in the stupa. The highest tensile stress occurs at the corner where the dome

meets the basal rings. The magnitudes of these tensile stresses are in the range of 0 kPa to 341 kPa which is smaller than the allowable tensile strength of old bricks.

The hoop stress contours (Fig. 12b) also show a majority of compressive stresses and they too tend to increase from top to bottom. As in other stress contours, a high concentration of stresses can be seen at sharp corners. The tensile hoop stress can be noted at the square chamber area, top of the dome and basal rings area. The magnitudes of these tensile hoop stresses are in the range of 0 kPa to 116 kPa. The highest tensile hoop stresses can be noted at the edges of the basal rings.



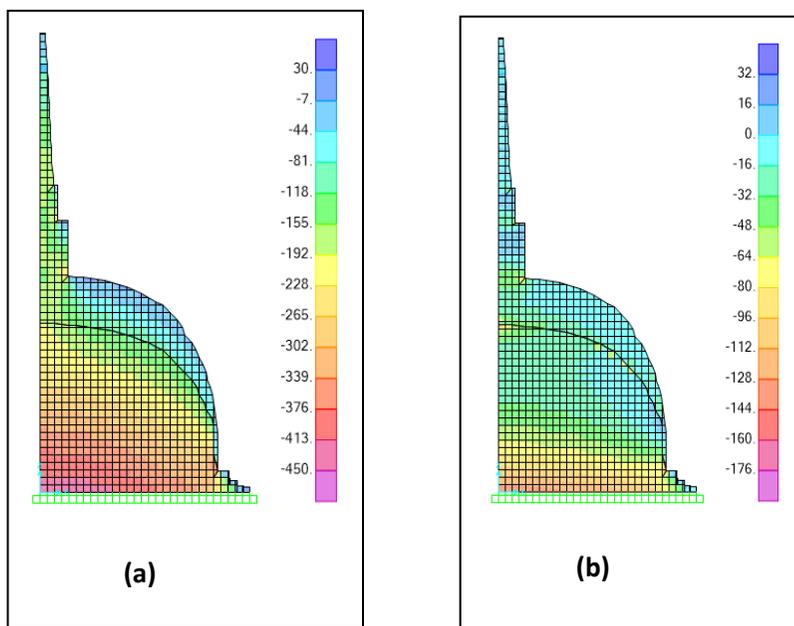
**Figure 12.** (a) vertical and (b) hoop stress contours ( $\text{kN/m}^2$ ) for the paddy- heap shape model

**Model 4 (Old Brick and New Brick Work, Proposed BubbleShape)**

A compressive stress variation (Fig. 13a) of 0 kPa to 435 kPa can be seen for the vertical stress in the stupa. Majority of the stresses are compressive and a tensile stress region can be noted in the basal rings area.

In this model, the existing area was created with old bricks and proposed area by new bricks. It can be noted that under self-weight most parts of the stupa is under compression and this compressive stress gradually increases from top to bottom. The maximum compressive stress occurs at the centre of the foundation level and its value is 435 kPa. At the outer surface of the dome no tensile stresses occur and tensile stresses can be noted in the areas where dome meets the basal rings area. Another variation which can be noted is the stress concentrations at the corners. Places where the square chamber meets the dome and where the dome meets the basal rings have a high compressive stress concentration compared to the surrounding areas. A sudden decrease in stress can be seen at the edges of the basal rings. This behaviour could be attributed to the fact that these places are sharp corners.

The hoop stress contours (Fig. 13b) also show a majority of compressive stresses and they too tend to increase from top to bottom. As like in other stress contours a high concentration of stresses can be seen at sharp corners. The tensile hoop stress can be noted at the square chamber area, top of the dome and basal rings area the magnitudes of these tensile hoop stresses range from 0 kPa to 34 kPa. The highest tensile hoop stress occurs at the corner where the basal rings are located.

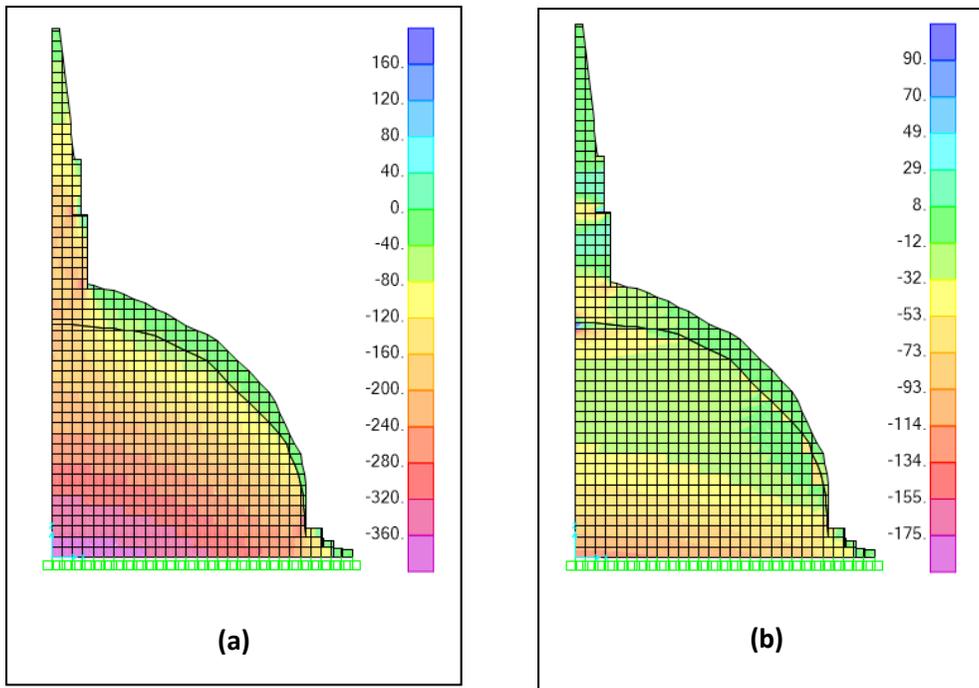


**Figure 13.** (a) vertical and (b) hoop stress contours ( $\text{kN/m}^2$ ) for the bubble shape model

***Model 5(Old Brick and NewBrick Work, Proposed Paddy-HeapShape)***

From the direct stress contours (Fig. 14a), it can be noted that, under self-weight, the stupa is under compression and this compressive stress gradually increases from top to bottom. A compressive stress variation of 0 kPa to 383 kPa can be seen for the vertical stress in the stupa. Tensile stresses can be noted at the basal rings' edges and no tensile stress at the outer surface of the dome. The magnitudes of these tensile stresses are in the range of 0 kPa to 184 kPa and the allowable tensile stresses of old bricks is 550 kPa.

The hoop stress contours (Fig. 14b) also show a majority of compressive stresses and they too tend to increase from top to bottom. As in other stress contours a high concentration of stresses can be seen at sharp corners. The tensile hoop stress can be noted at the square chamber area, dome area and basal rings area the magnitudes of these tensile hoop stresses are in the range of 0 kPa to 259 kPa. The highest tensile hoop stress occurs at the centre of the dome where the old and new brick intermediate surface.



**Figure 14.** (a) vertical and (b) hoop stress contours (kN/m<sup>2</sup>) for the paddy heap shape model

### **Results of the Interpretation of Finite Element Analysis**

Bubble and paddy-heap shapes are the two different shapes considered in the SAP2000 model analysis. The completed stupa with old bricks and completed stupa with new bricks have different stress distributions in the analysis. According to the analysis, the brickwork of the models is in compression and the vertical and hoop stress distributions are shown in Figures 10-14 respectively.

In each model, the stress gradually increases from the outer surface of the stupa to the center of the basal rings of the bottom plan. Maximum compressive stress can be seen at the center of the basal rings at the bottom plan.

In both shapes, the stress distribution patterns generated in the existing stupa portion after the restoration are quite similar as shown in Figures 13 and 14. The stresses of the finite element models 2 to

5, have been increased in considerable amounts than the stresses of the existing stupa. Finite element study showed a large region of hoop tension in the bubble shape model with old and new masonry dome (Fig. 13b). But the finite element study (Fig. 14b) showed a small region of hoop tension for the paddy-heap shape model with old and new masonry properties. The bubble shape SAP model which is reconstructed with new bricks has a maximum vertical compressive stress of 435 kPa while paddy-heap shape has 383 kPa as shown in Tables 8 and 9. The paddy-heap shape SAP model is selected as the most suitable shape, since its maximum vertical compressive stress is less than the bubble shape SAP model. The less height of paddy-heap shape compared to the bubble shape may cause less maximum vertical compressive stress to the paddy-heap shape. The stress increases rapidly at the interfaces of the old and new brickwork.

The finite element study showed a region of hoop tension stresses in the dome induced by the self-weight. In order to identify weak zones of the stupa, finite element stress analyses were conducted and shown in Fig. 13b and Fig. 14b. When comparing the two figures, it is apparent that the paddy-heap shape stupa dome has a small tension region under self-weight, but the square chamber and the cylinders have some hoop tension. However, in the bubble-shape stupa, the hoop stress distributes in a larger region of the stupa than the paddy-heap shape stupa. In both cases, the stresses are small compared to the strength of the relevant material, thus it could be safely concluded that they do not influence in the formation of cracks.

**Table 8.** Comparison of results, Alternative I (Stresses of the dome)

<b>Stresses</b>	<b>Alternative I</b>			
	<b>Option 1 (Old brick)</b>		<b>Option 2 (Old and new brick)</b>	
	<b>Compression</b>	<b>Tension</b>	<b>Compression</b>	<b>Tension</b>
Vertical stress (kPa)	428	0	435	0

**Table 9.** Comparison of results, Alternative II (Stresses of the dome)

Stresses	Alternative II			
	Option 1 (Old brick)		Option 2 (Old and new brick)	
	Compression	Tension	Compression	Tension
Vertical stress (kPa)	373	0	383	0

## Conclusions & Recommendations

The existing foundation spread area and its foundation depth was checked using the Ground Penetration Radar. According to the results of the Ground Penetration Radar, the foundation of the existing Neelagiri stupa is spread around the stupa for 2.87 m from the basal rings and the depth is 3 m from the existing ground level.

In this research, different alternatives for the restoration of the Neelagiri stupa have been proposed and analyzed. Through systematic experiments (dry density, Poisson's ratio, modulus of elasticity of bricks) on the collected brick samples with an analytical investigation including the literature review, the condition assessment of the existing stupa was performed.

Four finite element models were prepared using the SAP2000 software package considering two shapes and two brick types (old and new). Self-weight of the stupa was the applied external load. These models helped to arrive at the conclusion that all stresses increase from top to bottom and a tensile or low compressive stress region could be noted at the outer surface of the dome.

The maximum vertical compressive stress is lesser if it is possible to restore the stupa using old bricks due to low value of density of old bricks. However, it is not possible to supply large amount of old bricks for the restoration. Therefore, it is decided to restore the collapsed area of Neelagiri stupa with new bricks.

Finite element models' results showed that hoop tension stresses were induced in the dome by the self-weight. The model showed a small region of hoop tension for the paddy heap shape model with old and new masonry properties. However, those stresses are very small compared to the strength of the relevant material, thus it could be safely concluded that they do not influence in the formation of cracks. The self-weight and the shape of the stupa could be ruled out as a reason for the crack formation. Further, the shape of paddy heap is safer over the shape of the bubble for the dome of the structure as far as the stresses in the masonry are concerned. When considering the additional material usage and construction difficulties, among the two proposed superstructures, the paddy-heap shape possesses a more stable shape for the dome. However, due to the stresses generated in the existing masonry, these two shapes could affect restoration work.

Finally, the analysis and results approached to fulfil the research aim and objectives by proposing the paddy-heap shape to be used to restore the Neelagiri stupa using new bricks. According to the alternative II, the total height of the stupa is 50.57 m (without the kotha).

## **Acknowledgments**

Authors would like to acknowledge Dr. C.S. Bandara and Eng. Suranga Karunanayake of Department of Civil Engineering, University of Peradeniya for the help given during the experimental testing.

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## **The 31<sup>st</sup> OUSL General Convocation Address 2018**

**Torsten Henry Fransson, PhD. DSc.**

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### **Challenges and Changes towards a Sustainable Society: Climate, Energy and Education**

Today I have the special privileged of receiving a Doctor of Science Honoris Causa from The Open University Sri Lanka. The OUSL has been a pioneer in the open education sector in Asia since its creation in 1978, becoming the 3<sup>rd</sup> Open University in the whole of Asia (only 9 years after the world-wide first Open University, the OU UK in 1969, and a few years after Korea 1972, Pakistan 1974 and Thailand 1978). The purpose at its creation in 1978 was to provide higher educational opportunities to working adults, providing them the road to success, surpassing age, vocation, gender, race, ethnicity and religion. This has been a success, and the university has now 8 regional centers and around 40'000 students enrolled. This progress is a great achievement and I express my sincere congratulations to the OUSL, its leadership and the entire staff!

I would heartfully like to thank the Chancellor, Vice-Chancellor Prof S. A. Ariadurai, the University Faculty and all the colleagues at the OUSL for the Honory Doctorate. The results we over the years have commonly achieved of educating students from Sri Lanka towards a Master graduation from EU universities has been a significant achievement that could not have happened without a true collaborative spirit, and an openness towards the importance of education in a world-wide perspective, from colleagues both at OUSL and universities in Europe, and of course the dedication from the students themselves who made significant sacrifices during the study years. The evolution of creating such on-line collaborations already back in 2005 when internet was still in its infancy has been a second foresight from the OUSL, this time to work together with EU universities for the benefit of the citizens of Sri Lanka. As such the present leadership of OUSL has followed the tradition of academic openness, futuristic views and exploiting new ways towards higher

education that was at the origin of the university. Again congratulations to the OUSL.

*Dear graduates,*

A graduation convocation is a very important milestone in the life of an institution, and it is a great honor for me to be part of this occasion. I would, as you as fresh graduates embark upon new, highly exciting and fruitful careers, like to frame my thoughts, and remarks, towards the earth's and societies sustainability perspective, perhaps giving you some “food for thoughts” and perhaps even some inspiration towards your new careers.

*You go out into a divided world, but a world of enormous potential and opportunities.*

We have all the future destiny of the earth in our hands. As earth's stewards, we must strive for sustainable development, aim to reduce global injustices, to erase poverty, and ensure a full mitigation of climate change. Clean water and energy services are essential to all of these goals. And for this knowledge is a key, knowledge accessible for all. Increased knowledge will empower us to manage the earth's precious water and energy resources for the service of mankind.

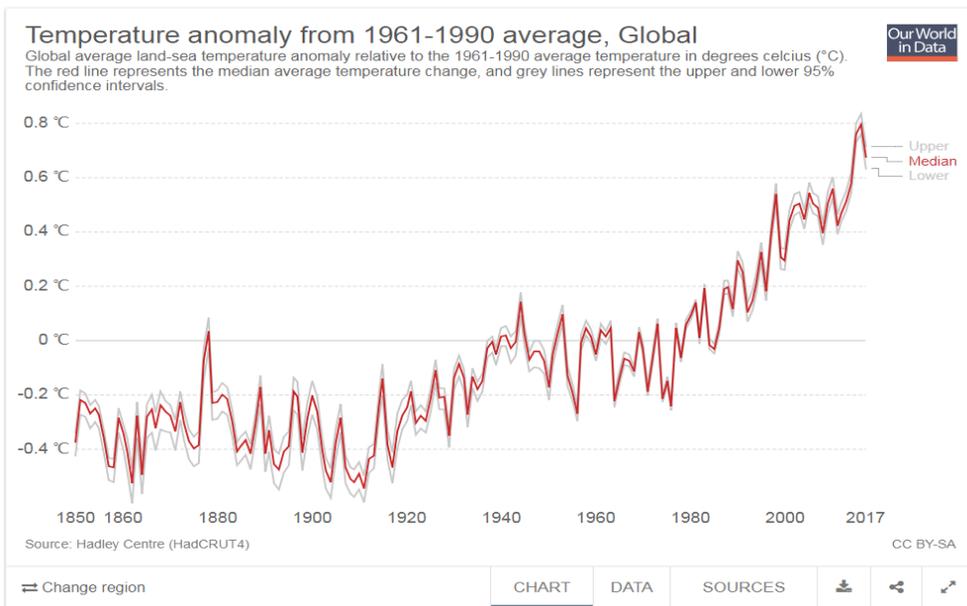
Access to clean, affordable energy and water, and appropriate food, all put in a humanitarian, social and environmental context, are the three main pillars of sustainable development. To overcome social injustices in these three areas, education at all levels is a key element.

Today the world faces unprecedented challenges. The United Nations has put up 17 essential Sustainable Development goals for the future (Fig. 1) where I in this address would specifically like to highlight the goals 4 and 7 which relate to “Quality education” and “Affordable and clean energy”.

These two are, together with goal number 6 of “Clean water and sanitation”, essential preconditions for all the other goals as without education, water and energy services the world will come to a stand-still, and the societal injustices we today find in the global world will not be reduced.



**Figure 1.** United Nations 17 Sustainable Development Goals (<https://tonyloyd.com/category/sdgs/>)



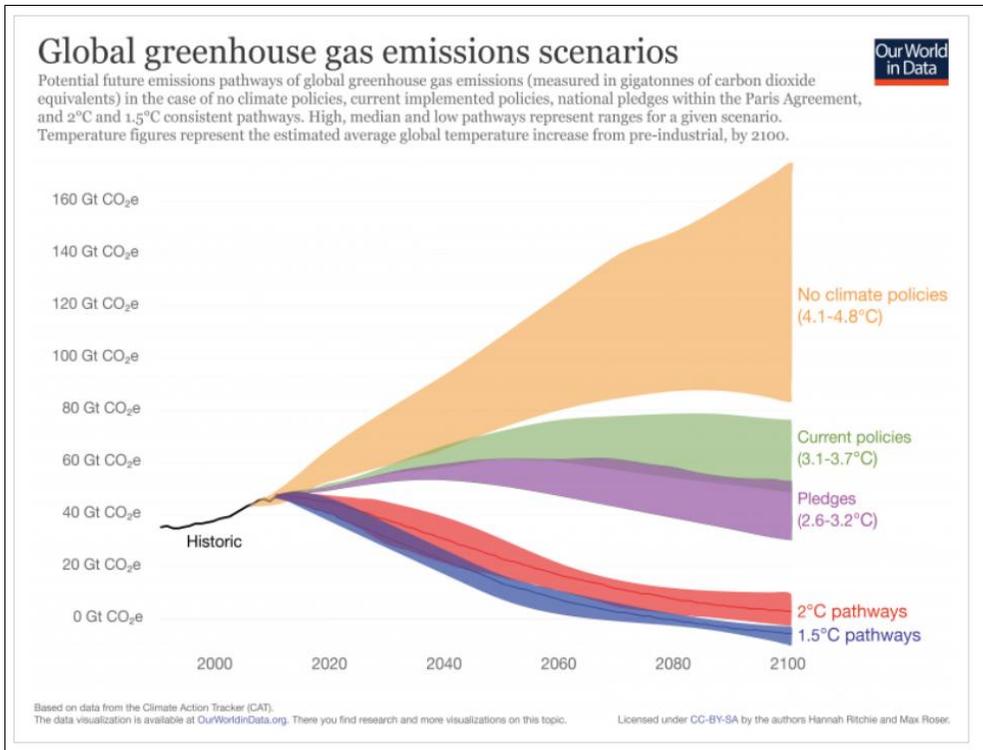
**Figure 2.** Global temperature variation 1860-2017, with the period 1969-1990 as baseline (<https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions>)

The recent warnings from the Intergovernmental Panel on Climate Change (IPCC) in October 2018<sup>1</sup> give clear warnings to policy makers and worldwide citizens that keeping the goal, approved by most governments in the world, of less than 1.5 degrees Celsius global warming compared to the pre-industrial situation requires very fast actions (Fig. 2).

The consequences of not reaching this goal can be disastrous for the world resulting in rising sea levels, disappearing islands and whole nations, extreme droughts, more and more weather-related natural catastrophes, and subsequent unprecedented migration of people between regions. The report indicates that we already presently can see some consequences of global warming, and that keeping the temperature rise to 1.5°C instead of the more realistic 2°C should significantly reduce the effects. In this context every bit of warming matters and the more actions that can be taken on all levels will help in this regard. Already at 1.5°C the consequences will in many cases be irreversible, at 2°C it will be disastrous and the consequences of the higher scenarios cannot be foreseen. Immediate actions are needed to reduce the CO<sub>2</sub> emissions for an acceptable climate by the end of the century. Scenarios indicate that zero net CO<sub>2</sub> emission is a necessity by 2050 (Fig. 3).

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<sup>1</sup> Report title: Global Warming of 1.5°C, an IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. [http://www.ipcc.ch/pdf/session48/pr\\_181008\\_P48\\_spm\\_en.pdf](http://www.ipcc.ch/pdf/session48/pr_181008_P48_spm_en.pdf)



**Figure 3.** Maximum allowed CO<sub>2</sub> emissions to keep the global temperature rise to x°C by the end of the present century. (<https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions>)

*All this does of course not sound good for the future of the planet Earth!* However, the good news is that several actions that would be needed to limit global warming to 1.5°C are already underway around the world, although they will need to significantly accelerate. This requires rapid and far-reaching transitions in land, energy, industry, buildings, transport, and cities. Global net human-caused emissions of carbon dioxide (CO<sub>2</sub>) would need to fall by about 45 percent from 2010 levels until 2030, reaching ‘net zero’ around 2050. But we will also need to, through various methods, continue on this path and also remove CO<sub>2</sub> from the air to be able to keep the 1.5°C until the end of the century. Highly efficient climate change mitigation technologies do exist already today, but they need to be more implemented and the cost must go down. As they do exist the main problem is the implementation. The challenge is the short-term cost towards the

long-term ones, and often also the fact that the most polluting nations are not the ones who will feel the burden first.

The IPCC report gives policymakers and practitioners the information they need to make decisions that tackle climate change while considering local context and people's needs. The next few years are probably the most important in our history. Different sectors will need to make strong commitments. Energy, agriculture and transport have significant reductions to do (Fig. 4). But the climate change mitigation shall not only be put upon engineers and technicians.

*In this perspective all you fresh graduates have, independent upon academic discipline, a possibility to make impact.*

Citizens must be informed, local and national politicians need to be pressured towards actions, political ambitions must be pushed forward and accepted by the citizens. Corporates need to, and many do already now, come forward to step up to mitigate climate change.

There will of course in the future be many more, and significantly more efficient, methods than today, but already the implementation of the existing technologies can mitigate and largely solve the greenhouse gas problem we face today. One important example is that the transfer to renewable energy (solar, wind, hydro, ocean/tidal, biomass,..) sources is already now possible. In some countries it starts to become cheaper to install solar power than fossil-fired units.

The global average solar radiation, per m<sup>2</sup> and per year, can transform the same amount of energy as a barrel of oil, 200 kg of coal, or 140 m<sup>3</sup> of natural gas. Still only about 1% of the electricity in the world is through solar power<sup>2</sup>. This is a huge potential for renewable energy, especially as the prices for solar panels are on a significant decreasing slope. Similarly, biomass contributes already ~10% of the global energy mix<sup>3</sup> and is also on a significant rise, mainly driven by the fact that biomass is CO<sub>2</sub> neutral over a period of a generation as long as there is new and continuous planting. Among other renewable energy sources with significant potential hydropower, waste-to-energy, geothermal, wind and marine can be mentioned. In short, there is no shortage of renewable energy resources in the world. So why do we

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<sup>2</sup> <https://www.worldenergy.org/data/resources/resource/solar/>

<sup>3</sup> [https://www.worldenergy.org/wp-content/uploads/2017/03/WEResources\\_Bioenergy\\_2016.pdf](https://www.worldenergy.org/wp-content/uploads/2017/03/WEResources_Bioenergy_2016.pdf)

still use the fossil fuel? It is a matter of price per unit. But these calculations are very short-sighted and do not consider the environmental cost of burning the energy which the sun has given us during millions of years and releasing all this CO<sub>2</sub> in a matter of a few hundred years.

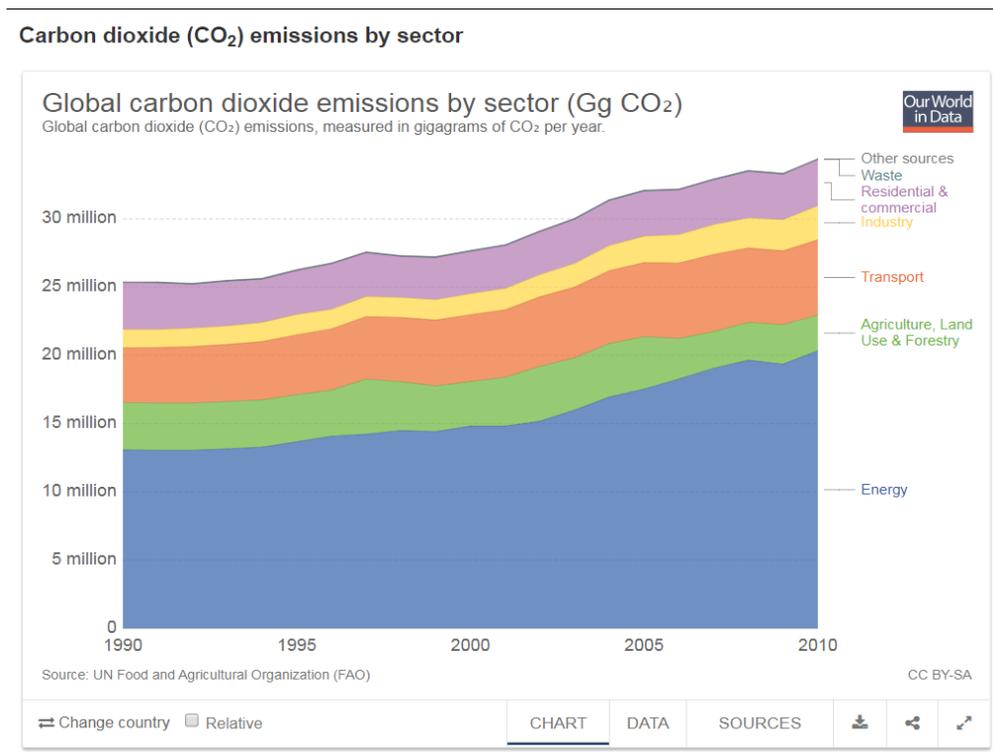
Although the United States has gone out of the Paris Climate agreement, everything is not completely “black” there either: California has among the toughest climate goals in the world, and they have just announced that the 2020 greenhouse gas emission target was already met 2016<sup>4</sup>! And several other states go in the same direction, independent of the US federal government’s declined interest in climate change.

*So what can we commonly do?*

The technology exists, the awareness is present in a number of governments but the urgency seems to be missing. As solutions do exist it is a matter of implementing and using these technologies. For this *education*, at all levels, is needed. School children needs to become aware of how the earth’s resources can be saved, citizens have to become aware of what can be done on a day-to-day basis and exercise their power in the democratic processes to combat climate change, engineers have to be educated towards implementing the latest technologies into their constructions, and politicians must be educated towards the global financial impact of not acting on time, and take their responsibility towards future generations.

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<sup>4</sup> Mechanical Engineering, Sept 2018, p. 15



**Figure 4.** CO<sub>2</sub> emissions from different sectors (<https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions>)

*Quality education:*

This brings me to the second, out of the UN Sustainability Goals for the future, important topic I want to raise, namely “*Quality Education*”. *This is a topic very fitting for you as fresh graduates to reflect upon*, starting with the question of how you think your education could have been even better than it was. Basic education should of course be a human right and is gradually becoming so in all countries. Such education should in the globalized world of today be broad, not only based upon achieved grades but ethics, integrity, personality as well as knowledge about the regions, global and local, and the societal factors influencing citizens choices. The higher education is, although global, not easy to handle, mainly as it is through national accreditation systems and as different cost models

exists in different countries. The main two cost models are “pay upfront for on-campus education” (that is, students pay the tuition fees for the studies) or “pay downstream for on-campus education” (which in most countries mean a long-term payback time through various taxes paid in the country one works in). These models have, together with the “open universities” in many countries, co-existed well for a number of years but the appearance of online education, the development of interactivity in education and Artificial Intelligence is presently drastically changing the educational landscape. The teacher of today is used to teach in the by now “classical ex-cathedra” way: The teacher has a significant monolog in front of a number of “physically present students” (Fig. 5), in a similar way as you now listen to me.

However, the appearance of “Massive Online Open Courses” distributed globally through special channels like Coursera<sup>5</sup>, EdX<sup>6</sup>, FutureLearn<sup>7</sup> (Fig. 6), and more, has drastically changed the educational landscape. Although there is not an educational revolution going on, it is a very fast evolution. Earlier academic and professional education was clearly separated. This is not any more the case. Students nowadays can learn from different global sources at virtually no direct cost, apart from the dedicated time and intellectual efforts needed. These drastic educational changes make many highly reputed universities going into the online market, offering various courses (both academic and non-academic) as well as both Master and Bachelor degrees. Very recently universities like Penn State<sup>8</sup> and others have come out with complete online programs offering also Bachelor degrees. The cost for such programs can at the present time land at 50%, or even 25%, of the cost for an on-campus program at these high-reputed universities. This opens significant possibilities for global students to receive high-quality education at a significant lower cost than the traditional on-campus programs, at the same time as it also challenges the traditional “open universities” around the world. We have only seen the very beginning of such an evolution. One, often neglected, part of this will be the selection and admission process. The traditional way of “best academic grades” and then going directly from high-school to university will be challenged as people will continuously move back and forth between education and work, to

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<sup>5</sup> <https://www.coursera.org/>

<sup>6</sup> <https://www.edx.org/>

<sup>7</sup> <https://www.futurelearn.com/>

<sup>8</sup> <https://www.worldcampus.psu.edu/degrees-and-certificates/directory/undergraduate/bachelor>

continuously update the knowledge in the original trade, while also “changing gears” and start completely new specializations. New ways of accepting students to university courses will change as a result of academic accreditation of MOOCs as these become, as a function of the transparency, peer review and the large number of users, of increasing quality. The main important issue in this process will be to ensure the high quality of the Overarching Intended Learning Outcomes (= the officially, published educational goals) of individual courses as well as programs, and ensuring corresponding and academically appropriate assessments. As such MOOCs will soon be accepted also as giving academic credits, and will thus open up for receiving accredited university education from non-university educational providers.

A second very important trend, and one with significant potential, is the “Team-based Societal Challenge education”<sup>9</sup>. This is another step away from the “ex cathedra teaching” in the sense that the learners are presented with a societal challenge in the beginning of the studies, and learn the necessary topics to solve the challenge “just in time” when the knowledge will be needed. This gives the learner a much higher motivation as they immediately understand how they can apply the knowledge from the course, and it also corresponds to how the graduates will later engage in the working environment. Of course, the teacher must take care to ensure that the education remains broad towards also other applications. This also means that not all students shall have the same background. In fact, putting students from law, political science, technology, and for example philosophy, food and health, etc together to solve societal challenges sparks significant new ideas and innovations. In this perspective it is also easy to imagine, but of course difficult to realize and implement, that students will need to find their own learning pathways, away from the classical “one size fits all” education. This implies that it will be needed for teachers to work together in new ways, also sharing and together develop educational material, instead of individual teachers developing material (often in duplication) by their own. This can for example be done through the creation of repositories of sharable learning units, where both teachers and students can find re-usable learning units for individual path-ways and learners can receive “micro-degrees” in different areas to enhance their careers (Fig. 7).

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<sup>9</sup> See for example: <https://www.kth.se/social/group/guide-to-challenge-d/>

*With this evolution what will then education be like in the world of the future?*

The human brain is slow to adapt new technology, but the evolution with computers is going fast. Internet use, also for school purposes, is going down in the ages. Younger people will adapt the technology very much faster than the professors today occupying the teaching positions. In Sweden 79% of all children use today internet before they are 2 years old (49% on a daily basis), and when they are 10 years old they use regularly internet in the school-work<sup>10</sup> (Fig. 8).



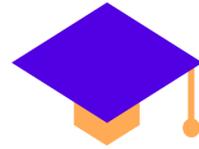
**Figure 5.** Example of “traditional ex-cathedra” education

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<sup>10</sup> <https://2017.svenskarnaochinternet.se/barn-och-internet/>

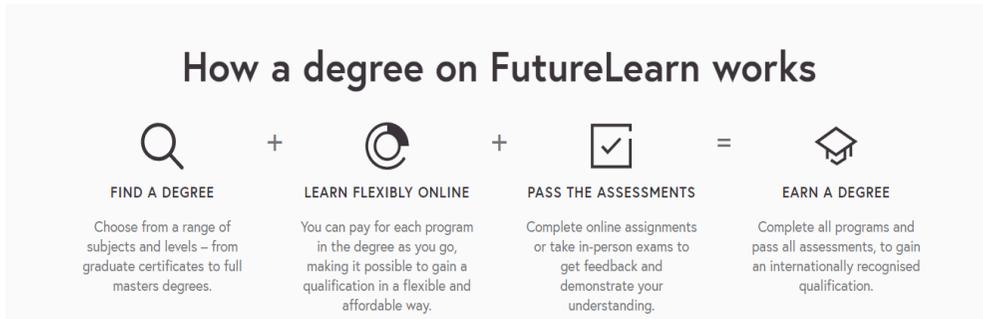
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**Figure 6.** Example of courses and degrees offered on-line, in collaboration with worldwide leading universities. (<https://www.futurelearn.com/degrees>)

When these persons come to the university, they will be much more used to seek information “from anywhere” than the present university generations. University teachers of today are still in the old paradigm that they shall be the providers of the basic knowledge. But if this traditional knowledge is already available outside the universities, *what will the purpose of the university be? And more specifically what will the role of the teacher become?* The traditional teaching must definitely change. Exactly how is not known but the tendencies at the present time go towards much shorter courses, to attract the shorter attention span of the “computerized” generation, ensuring that there will be significant “rewards” on a daily basis in the direction of gamification of education and scenario buildings. The traditional teacher will have to change perspective and become more like a guide,



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**Figure 7a.** Possibility for “the 2030 student” to organize their own learning paths



**Figure 7b.** An example of a repository that stores basic learning units, accessible to both teachers and learners in a global perspective

Coach and mentor who will not be “teaching” but rather setting up the educational framework about the Intended Learning Outcomes (ILO) and assessing that the learners have the requested knowledge, skills and competences corresponding to these ILOs upon graduation (Fig. 9). Adaptive courseware, sometimes called intelligent tutoring systems<sup>11</sup> have grown increasingly popular as an alternative to large classes that emphasize lecture and memorization. They have also given rise to the specter of the robot teacher. With adaptive courseware, students first encounter material outside of class, often through short video lessons and readings. They take quizzes that assess their understanding of the material and, depending on the results, the courseware either advances them to the next lesson or provides supplemental instruction on concepts they don’t yet grasp. This let students’ study at their own pace and frees up the instructor’s time in class to instead have in-depth intellectual discussions with the learners. Furthermore, an educator spends usually a tremendous amount of time grading homework and tests. The traditional assessment related to basic engineering calculations can already now be automatically corrected but this possibility is seldom used by teachers.

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<sup>11</sup> <https://www.chronicle.com/article/How-Artificial-Intelligence-Is/244231>

### “Learning units” in the repository

Draft\_IJES-PSM2100C1T5L1N1:  
Introduction to the bioenergy topic

Home
General info
ILOs
Assessment Context and ALOs
Attributes and Syllabus
Supporting Knowledge Material

**Learning Time:** 17h 17 min  
**Teacher:** Prof. am Björn Zellwies

**ILOs:**  
**K1:** Identify how much biomass makes up of the total world energy raw material  
**K2:** Identify the fundamental aspects of bioenergy  
**K3:** Distinguish the different biomass resources

**Nugget summary:**  
 This is an introductory nugget to the bioenergy topic. It contains four sections. Fundamental aspects of bioenergy are primarily discussed. The general and global trend towards an increase in share of renewables in the energy system has so far only started. The primary energy supply is dominated by oil. On the other hand, biomass share to the global primary energy supply is growing. Throughout the bioenergy course, the Federal European Standard EN14588 is followed in order to explain the terminology and definitions related to bioenergy used in the course.

**Uniqueness:**  
 The distinction between the three common terminologies: Biomass, bioenergy and biofuel are discussed by following the Federal European Standard EN14588, which clears the confusion between these terminologies that the user might experience when referring to different literature on the internet. It gives an insight to the fundamental aspects of bioenergy based on a cutting edge course material and video lectures.

**Questions**

Teachers develop the “learning units” they want to share. Together they create courses and programs  
Presently: ~40 teachers from ~25 universities

Draft\_IJES-PSM2100C1T11N1:  
Introduction to Fuel Cells

Home
General info
ILOs
Assessment Context and ALOs
Attributes and Syllabus
Supporting Knowledge

**Learning Time:** 2h 05 min  
**Teacher:** Valentina Zaccaro  
**Teacher Profile:** [Click here](#)  
**Three top ILOs:**  
**K1:** understand the course structure  
**K2:** understand fuel cell working principle  
**K3:** comprehensive overview on fuel cell advantages

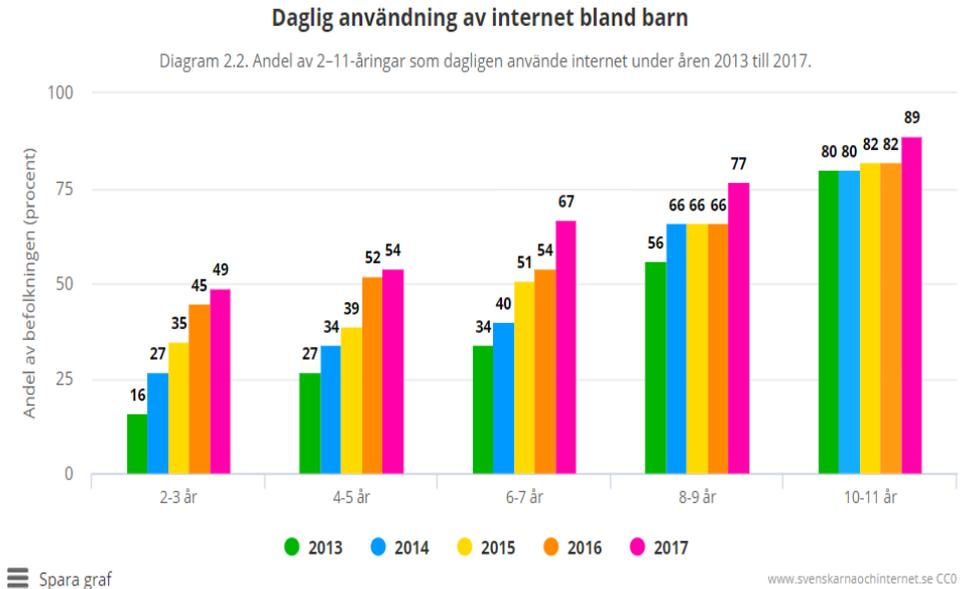
**Nugget summary:**  
 An overview of the lesson will be given in this nugget with details to understand the lesson structure, the individual exercises, and the final assessment criteria. Fuel cell working principle and electrochemistry will be explained. A general overview will be given regarding fuel cell systems and their potentials for a high-efficiency, electricity energy grid.

**Uniqueness:**  
 The need for cleaner and more flexible energy conversion solutions is driving the development of fuel cell based systems. In this nugget, a unique overview of fuel cell technology will be given.

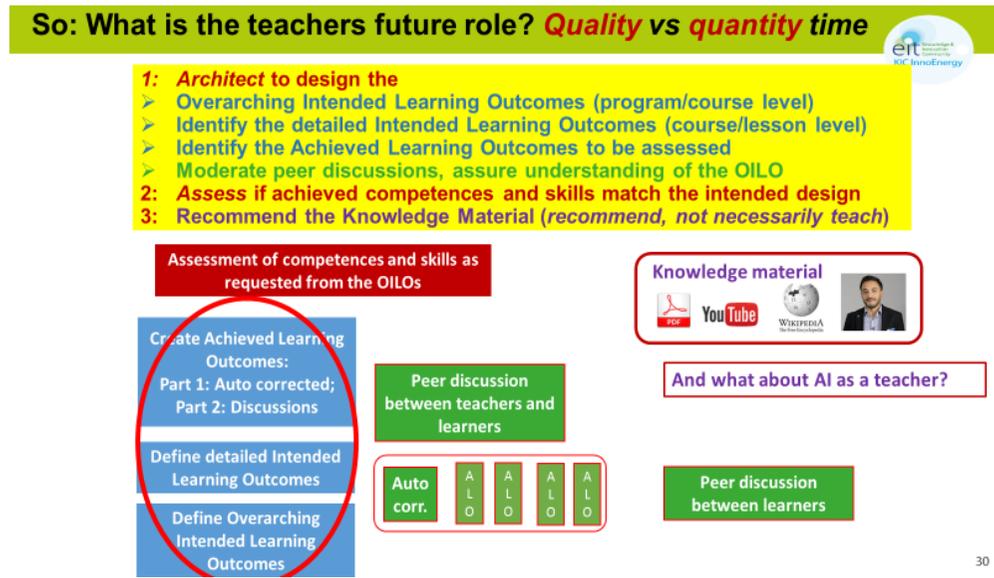
**Figure 7c.** Example of small, globally accessible “learning units”, to be used both for individual learning and for commonly creating better and more sophisticated courses



**Figure 7d.** Example of a “stackable” concept in which the learner gradually builds up their knowledge, skills and competences by “stacking” a number of “micro-credentials” from many different sources toward a broader degree



**Figure 8.** Daily internet use by youth in Sweden (<https://2017.svenskarnaochinternet.se/barn-och-internet/>)



**Figure 9.** As learning material exists outside the traditional university the teacher’s role need to change towards a “tutor/mentor/coach” for enhances quality time

This is however rapidly changing and “simple” exam questions will more and more be handled automatically. Furthermore, Artificial Intelligence (AI) will step in, take over manually corrections of exams and at the same time offering recommendations to learners for how to close the gaps of missing knowledge. Machines can already grade multiple-choice tests, and they are very close to being able to assess written responses as well. As AI steps in to automate admin tasks, it opens up more time for teachers to spend with each student, thus going from “quantity time” to “quality time” and “personalizing” the learning process (Fig. 9). There is also much potential for AI to create more efficient enrollment and admissions processes, offering great potential for persons who might have other qualifications than the absolute highest grades in the class to become enrolled. Although education might be a bit slower to the adoption of artificial intelligence and machine learning than

other branches, the changes are beginning and will continue. It is expected that artificial intelligence in U.S. education will grow by more than 45% from 2017-2021<sup>12</sup>. Stanford University, one of the most prestigious universities in the world has had significant internal discussions over the last few years about the future of the university as a whole. They have explored different scenarios, each groundbreaking as towards a major shift from the traditional undergraduate education in “disciplines” towards “something new”, so far completely unknown<sup>13</sup> (Fig. 10). This means that universities world-wide presently struggle with what their role will be in the future.

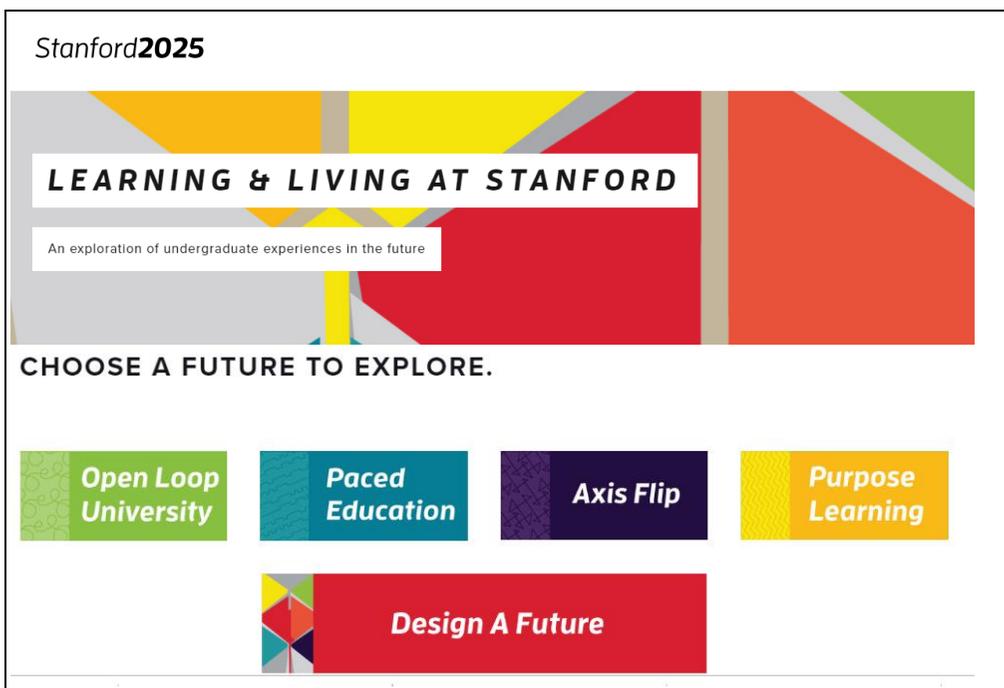
Even though most experts believe the critical presence of teachers is irreplaceable, there will be many changes to a teacher’s job and to educational best practices. Artificial Intelligence has already been applied to education primarily in some tools that help develop skills and testing systems. As AI educational solutions continue to mature, AI can help fill needs gaps in learning and teaching and allow schools and teachers to do more than ever before. AI can drive efficiency, personalization and streamline admin tasks to allow teachers the time and freedom to provide understanding and adaptability—uniquely human capabilities where machines would struggle. By leveraging the best attributes of machines and teachers, the vision for AI in

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<sup>12</sup> <https://www.forbes.com/sites/bernardmarr/2018/07/25/how-is-ai-used-in-education-real-world-examples-of-today-and-a-peek-into-the-future/#6de760a5586e>

<sup>13</sup> <http://www.stanford2025.com/#intro>

education is one where they work together for the best outcome for students. Since the students of today will need to work in a future where AI is the reality, it's important that our educational institutions expose students to, and use, the technology. Adjusting learning based on an individual student's particular needs has been a priority for educators for years, but AI will allow a level of differentiation that's impossible for teachers who have to manage many students in each class. There are several companies currently developing intelligent instruction design and digital platforms that use AI to provide learning, testing and feedback to students from pre-Kindergarten to college level that gives them the challenges they are ready for, identifies gaps in knowledge and redirects to new topics when appropriate. As AI gets more sophisticated, it might even be possible for a machine to read the expression that passes on each individual student's face that indicates they are struggling to grasp a subject and modify a lesson to respond to that. The idea of customizing curriculum for every student's needs is not viable today, but it will be for AI-powered machines.



**Figure 10.** Scenarios about the future of university as discussed by Stanford Universities

*Is this a vision of today or of tomorrow?*

During the 40 years of information age, we told computers what to do. With advances in artificial intelligence, particularly machine learning, and faster processing chips we can feed computers giant data sets and they can (in narrow slivers) draw some inferences on their own. The first step will be fully automatic assessments, but guidance systems where the computer directs us towards missing information will not be far away<sup>14</sup>. And once this has happened there will be a competency management in which learners can themselves, with the guidance of Artificial Intelligence select their own learning paths receiving scores, badges and micro-credentials, going into full degrees, even outside the university settings. *Questions like what might be the right balance between teachers and technology will have to start to be seriously considered and discussed.* This shift of teachers from knowledge providers to coaches/mentors and discussion partners will also change the perspective of who will be “teaching” at the university. Already today non-academics are invited to university classes to talk to students about their work and experiences. This will become significantly more common and as such you, fresh graduates, should aim to keep the contact with the university. *You can yourself become guides and mentors towards the next generation of students!*

We can of course not say what the future will look like, but based upon the technology progress and the speed of society today it is a safe bet that life-long learning with a person “going back to school” to take formal classes will increase. The majority of employees will not work in a “life-long employment” as previous generations in the field they graduated, and companies will more and more be looking for “fresh blood” to re-vitalize their environments. *Come back to school, explore new courses, and work with the OUSL to share your future experiences into a modern educational setting for the benefit of future students.* On the other hand, the AI will also be prone to manipulations, and it is vital to ensure that it is used for the benefit of society and not as a manipulation tool from organizations and governments. Also, here your direct academic sincerity is needed.

In closing let me extend my warm congratulations and greetings to each one of you, my fellow graduates. The degree you have just received is one stepping stone on the learning pathway towards

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<sup>14</sup> <http://www.gettingsmart.com/2018/08/32-ways-ai-is-improving-education/>

continuously increased knowledge, skills and competences. *As you set out on the next steps of your journey and as you cross many more milestones that mark your achievements, I am sure that you will proudly recall the opportunities that the OUSL gave you and how it empowered you for success. Make sure that you add your personal qualifications while keeping the academic integrity and devotion at the very highest level. Keep the “moral compass” high and ensure ethical approaches in all lines of work and duties. Join forces in multi-disciplinary teams to address the important societal challenges expressed in the UN sustainability goals, and ensure that also the ones who might not have had the opportunity to receive a high-level education like yours can be on board for the journey towards the future. You, as fresh graduates, have a privilege to participate in the development and act as earth’s stewards towards a sustainable future for mankind.*

*Good luck, and thank you for your kind attention.*

**Professor Torsten Henry Fransson**

**Email:** [torsten.fransson@kic-innoenergy.com](mailto:torsten.fransson@kic-innoenergy.com)

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