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The authenticity of Sustainable Practices in Sri Lankan Construction Industry

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Abstract

Sustainable construction practices make a significant impact on the construction industry itself, natural and social environment, and the economy of a country. Therefore, this study aims to identify important factors that influence the construction industry in adopting sustainable construction practices and sustainable construction practices adopted in Sri Lanka. This research is limited to construction organizations and construction industry professionals to collect data. Four construction organizations and seven professionals were selected as a sample, and semi-structured interviews and semi-structured in-depth interviews were conducted respectively. Content analysis and a stakeholder analysis were done to meet the objectives of the research. The content analysis was based on a framework proposed in the previous study, and the findings show that the construction organizations have passed the early stage of sustainable construction. Still, there are more to improve and develop. Awareness, training, and education/negative attitude, gaps in the legal framework and enforcement, non-availability of materials and suppliers, lack of research and development on sustainable construction practices were identified as essential factors in implementing sustainable construction practices.

Keywords: *Construction Organizations; Construction professionals; Construction Industry; Sustainable Construction Practices.*

Introduction

Environment, economy and society are perceived as separate entities. Still, they are always interconnected as the economy depends on the society and environment at the same time; human existence and society depend on the environment. The environment is the surrounding or the conditions in which a person, animal or plant lives or just about the natural world around us. As human beings depend on the environment, every person on the earth is responsible for environmental protection and conservation. The economy is "the state of a country or region regarding the production and consumption of goods and services and the supply of money" (Oxord, 2018). According to the Oxford Dictionary, the society is "the aggregate of people living together in a more or less ordered community" (Oxford, 2018).

Due to the various changes in the world like globalization, urbanization and industrialization, the natural environment, economy, and society have been faced with many changes so far. The issue of environmental pollution has grown in importance in the light of recently as the world is being met with critical environmental issues like global warming, acid rains, ozone layer depletion. Therefore, environmental conservation has become a growing concern all over the world recently.

The introduction of the concept of sustainability is a turning point of environmental conservation. A commonly used definition of sustainability was established by the United Nations World Commission on Environment and Development report in 1987 entitled Our Common Future. This definition states: "Humanity can make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs".

Along with the emergence of the concept of sustainability, all the communities and their industries started to pay attention to this concept. Among those industries construction industry is significant as it is one of the dynamic and environmentally, socially affected industries at present, that has a substantial impact on the economy of any nation.

As a booming industry, the use of sustainable construction practices is increasing all over the world and has become a trend. This concern has been growing at a rapid rate in the construction industry as the building construction affect the environment, society and economy. As per the Global Status Report 2017, "Buildings and construction together account for 36% of global final energy use and 39% of energy-related carbon dioxide (CO2) emissions when upstream power generation is included" (Abergel, et al., 2017). As stated by Bourdeau (Bourdeau, 1999), due to the direct and indirect linkage of the construction industry with economic, social and environmental aspects, it is absolutely an essential sector to achieve sustainable development.

According to Emmanuel (Emmanuel, 2004), the increasing urbanization and industrialization and living standards throughout the world have turned the creation of the built environment into a rising threat to the natural environment. Further, he has stated that the rapid increases in the building industry contribute to resource depletion, waste generation and energy consumption and also Al Hathloul (Al-Hathloul, 2004) has described that the construction sector has resulted in the escalation of domestic energy consumption per capita. There has been an increasing concern over the impacts of construction activity on the environment and sufficient measures have not been taken to mitigate them. But the traditional practices of the construction process fail to control the current challenges occur in construction industry (Jayalath & Gunawardhana, 2017).

As mentioned above, there is a massive impact on the construction industry on the environment. Mainly the buildings as one of the outputs of the construction industry, largely reflect these impacts during its lifecycle (Zuo & Zhao, 2014). They consume space and natural resources, and they require cement and other building materials like Sand (Majdalani, et al., 2006). Further, they have stated that even during the construction, there are several pollutants and noise are released, and the workers and nearby residents are exposed to them. After construction, occupants consume water and generate wastewater and solid waste and buildings also consume energy and release carbon dioxide etc. to the environment. Moreover, finally, even if buildings are demolished, rubble and debris are released to the environment. Therefore, it can be understood that the construction industry has an unavoidable impact on the environment which cannot be neglected.

The environment is not the only aspect that construction industry effects on. In the construction industry, social equity and cultural issues have also been promoted such as (Zuo & Zhao, 2014) providing buildings and facilities for the satisfaction of human being's requirements, providing employment opportunities and contributing to the national economy. Horta *et al.* (Horta, et al., 2013) further stated that the construction industry has significant influences on society as it is one of the major employers in most countries, accounting for around 7% of total employment worldwide. Even though the environmental impacts such as pollution, and consumption of resources are negative, the above-mentioned social factors provide positive impacts on society.

Apart from the environmental and social aspects, the construction industry affects the economy as well. As Spence & Mulligan (Spence & Mulligan, 1995) stated, the construction industry affects various aspects of economic development through the creating of physical

assets. According to Majdalani *et al.* (Majdalani, et al., 2006), for a sustainable economy, more infrastructure and facilities are needed, and therefore construction industry plays a significant role in that aspect.

By considering the above details, the necessity of adopting sustainable construction practices for building construction to reduce the inverse impact on the environment can be recognized. Shafii *et al.* (Shafii, et al., 2006) described that it is necessary to find out environmentally and economically sound design and development techniques for buildings and infrastructure for them to be sustainable.

Due to the high fragmentation and impact on the socio-economic aspects of the construction sector, it has a great responsibility in any sustainable development initiative (Majdalani, et al., 2006). Further, Shi *et al.* (Shi , et al., 2012) stated that the construction industry could be recognized as a significant sector involved in achieving sustainability as it has a significant impact on environment and society. Therefore it is clear that present environmental and socio-economic problems can be offered a first-rate response by sustainable construction (Yunus & Yang, 2011).

Hill & Bowen (Hill & Bowen, 1997) quoted sustainable construction as "the creation and responsible management of a healthy built environment based on resource-efficient and ecological principles". Moreover, Dickie & Howard (Dickie & Howard, 2000) defined sustainable construction as "the contribution of construction to sustainable development" while Parkin (Parkin, 2000), describes sustainable construction as a construction process that incorporates the underlying themes of sustainable development.

Applying the concept of sustainability to the construction is complicated as it is needed to be considered the sustainability of the

building from the initial stage. Accordingly, to be sustainable, a building must be sustainable by the structure itself and also, it should be environmentally friendly and energy-efficient throughout its lifecycle and even at the demolition. A sustainable building is the output of the sustainable construction process. Robichaud & Anantatmula (Robichaud & Anantatmula, 2010) have identified four pillars of a sustainable building, i.e. minimization of impacts on the environment, enhancing the health conditions of the occupants, the return on investment to developers and local community and the life cycle consideration during the planning and development process. If these four pillars are taken into account, it can be identified that those aspects have gone beyond the construction stage. They clearly show that sustainable construction must benefit the society starting from inception level up to the demolition of the building.

Sustainable construction ensures that the quality of the environment, society and the economy is protected and enhanced for future generations. Here the challenge that is faced by the construction industry is to keep the balance between providing a quality product and minimizing impacts on the environment. To obtain sustainability, some principles aim to reduce negative impacts on the environment and improve the health and comfort of buildings for occupants. Sustainable design principles are, optimizing site potential, minimizing non-renewable energy consumption, using environmentally friendly products, using energy and water-efficient appliances, reducing potable water use, enhancing indoor environmental quality, Optimizing operational and maintenance practices (Geelong, 2017).

Sustainably designed buildings provide health and comfort for their occupants through sustainable construction principles. Moreover, when considering the all benefits of sustainable construction to the

environment, society and economy as well, it is clear that it is of the utmost importance.

Therefore, directing to the sustainable construction practices by all stakeholders of the construction industry is significant. In this case, as a stakeholder, construction organizations play a significant role in the adaptation of sustainable construction practices. Hence it is essential to identify the sustainable construction practices, issues in adaptation and the remedies to be taken.

Even though there is a trend of using sustainable practices in constructions all over the world, in Sri Lanka, there is a slow direction towards this concept. According to the Lamudi Real estate market report, 79% of real estate agents surveyed in Sri Lanka believe interest in green buildings increased between 2014 and 2015.

According to (Munasinghe, et al., 2018), there has been remarkable attention to "Green Buildings" by planners, developers, and investors. It is claimed that green-certified buildings have lower operating costs and increased asset values and that they offer a healthier and safer environment for occupants. However, there is a somewhat slow process of using sustainable construction in operations. The reason may be the issues faced by the contractors in adopting this concept. Therefore, it is essential to identify the problems faced by construction organizations.

Accordingly, this research attempts to identify the problems faced by the construction organizations in Sri Lanka in the adaptation of sustainable construction practices. Hence this research provides a useful guide for construction organizations to identify their gaps in the adaptation of sustainable construction practices and also guides decision making authorities on the issues in the adaptation of sustainable construction practices to take appropriate measures.

This research is based on stakeholder theory. However, in this research, it is not attempted to collect data from all the stakeholders due to the inconvenience of contacting all the stakeholders. Hence the data is collected from construction organizations and professionals only.

The data collection from construction organizations is focused on selected leading construction organizations which are currently engaged in sustainable construction in Sri Lanka. Small-scale contractors are not considered here. Also, this research is concentrated on the building construction sector only.

The objectives of the study

The issues in the adaptation of sustainable construction practices by construction organizations were aimed at identified by this research. The general objective was to analyze issues that affect the adaptation of sustainable construction practices by Sri Lankan construction organizations in building construction. The specific objectives were, to identify sustainable construction practices adopted by Sri Lankan construction organizations, to examine the barriers for sustainable construction practices in Sri Lankan building construction industry and to develop an action plan for Sri Lankan building construction organizations.

Methods

In order to meet the objectives of the research, first, an extensive literature survey was carried out to identify the possible guidelines on sustainable construction practices in Sri Lanka and accordingly a framework proposed by Athapaththu & Karunasena (Athapaththu & Karunasena, 2016) has been referred in this research.

For the primary data collection, professionals involved in sustainable construction were also selected in addition to the construction

organizations to obtain rich data. Accordingly, four leading construction organizations with CS2 grading (CS2 is the highest grade of contractors in Sri Lanka as per the Construction Industry Development Authority) which had engaged in projects where principles of sustainability were implemented were selected purposively. Seven professionals were selected using the snowball method.

The data on which the research is based comprises primary data which was obtained for this research and a minimum ratio of additional data collected from the websites of the construction organizations as secondary data.

A semi-structured interview is a meeting in which the interviewer does not strictly follow a formalized list of questions, and more open-ended questions are asked, allowing for a discussion with the interviewee that allows new ideas to be bought up during the interview as a result of what the interviewee says. Also, according to the literature, the semi-structured interview has been identified as a preferable method for qualitative research data collection. Hence data was collected through the semi-structured interviews held with the selected construction organizations and professionals. Semi-structured interviews were held as face-to-face interviews. Two separate guidelines were used in interviews for construction organizations and professionals focusing on the objectives of the research, comprising both close-ended and open-ended questions. Interviews were recorded with the permission of the interviewee.

The interview guideline of construction industry had two parts. The first part was focused on obtaining the general information of particular construction company like registered name, years of experience in the construction industry and years of experience in sustainable construction, the green projects involved. The second part

consists of themes and open-ended questions that discussed in-depth, regarding sustainable construction such as the importance of sustainability concept to the construction industry, it is applicability to Sri Lanka, the current attitude of construction organizations towards sustainable construction, sustainable construction practices that have been adapted, barriers and issues in the adaptation of sustainable construction practices, organizational policies, vision and mission to cover principles in sustainable construction, research and development on sustainable construction practices and remedies taken to face those issues and suggestions.

The interview guideline of professionals contained with open-ended questions focusing the stakeholder analysis such as sustainability and importance in the construction industry, its applicability in Sri Lanka, the role of a professional in sustainable construction as a stakeholder of construction industry and its importance, the current attitude of construction organizations and professionals towards sustainable construction, sustainable construction practices that are adapted currently in Sri Lanka, barriers and issues in the adaptation of sustainable construction practices, adequacy of Research and Development on sustainable construction practices, actions that should be taken to make the small-scale construction organizations to get involved in sustainable construction, actions that should be taken to improve the professional involvement.

This research is based on qualitative data, and therefore, content analysis was done to meet the objectives of the study.

The information on data collection and analyzing are illustrated in the table below.

Data Collection and Analysis Methods

Specific Objective	Data Collection Method	Data Analysis Method
To identify sustainable construction practices adopted by Sri Lankan contractors.	Semi-structured interview	Content Analysis
To examine the barriers to sustainable construction practices.	Semi-structured interview	Content Analysis

Results and Discussion

Sustainable construction practices adopted in Sri Lanka

The introduction of the concept of sustainability is a turning point of environmental conservation. A commonly used definition of sustainability was established by the United Nations World Commission on Environment and Development report in 1987 entitled Our Common Future. This definition states: "Humanity can make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs". According to Shi et al. (2014), the shift of the construction industry from the traditional paradigm towards sustainable development has received close global attention in the form of "sustainable construction".

Athapaththu & Karunasena (Athapaththu & Karunasena, 2016) has proposed a framework for sustainable adaptation of the construction industry that has been derived through suggestions of experts in Sri Lanka and the Persian Gulf to deliver sustainable construction in Sri Lanka. In their research, they have suggested that to deliver sustainable construction in Sri Lanka through contractor organizations, structured long-term strategic visionary leadership that can be supported by the proposed framework is needed. Accordingly, it has been identified as vital areas as;

1. Legal framework and enforcement
2. Sustainable construction standards, guidelines or policies
3. Sustainable design
4. Sustainable procurement
5. Sustainable technologies, processes and innovations
6. People and organizational structure
7. Sustainable education and training
8. Sustainable measurements and reporting

In this section, sustainable construction practices currently adopted in Sri Lanka is compared with the framework suggested by Athapaththu & Karunasena (Athapaththu & Karunasena, 2016).

Legal framework and enforcement

There are several frameworks, rating systems used in Sri Lanka. "Blue-green Sri Lanka" (Neela Haritha) is the Green Building guidelines for Sri Lanka which is implemented through Urban Development Authority (UDA). This was initiated through the president's Neela Haritha program with the base of that this should not be a business and should check the sustainability accurately. This was launched in January 2017 and since 2017, January it is compulsory to get this certificate to government and semi-government buildings. Usually, when constructing a building, it should be taken the approval from the Urban Development Authority, and this programme goes parallel with that. Therefore, to get the building approval for government and semi-government building, it is compulsory to get a green standard. For private buildings, it is not compulsory, but it is issued after the same assessment if they request.

UDA always promotes this to register once it is decided the construction and not after the design is done. After registration, UDA issues guidelines and then according to that guidelines building has to be designed, because converting already designed building by the

guidelines is difficult. If that building has come to the preliminary planning stage at UDA building registration, without registration number of green certification, P.P.C. (Preliminary Planning Clearance) number will not be issued. Therefore, P.P.C. will be received if registered only. Then there is a control, that it is going to construct a building, with the knowledge of green guidelines. Then at the point of issuing Development Permit, it is checked whether the building complies with the building regulations as if it does not comply, there is no use of issuing the green certificate. While constructing, the site is visited by relevant officers at least three times to check whether it is constructed accordingly. Then once the construction is over, when getting C.O.C. (Certification of Conformity) it is again checked whether it complies with building regulations. C.O.C. is not issued until giving a final green certificate.

After launching in 2017, at the practice, it has identified the issues regarding the guidelines such as some percentages are too higher for Sri Lanka, some practices are not sufficient enough to impact on the green. Therefore, it was checked by professionals, and the next edition is to be launched at the second anniversary of the "Blue-green Sri Lanka" (Neela Haritha) in January 2019 (UDA, 2018).

Sustainable Construction Standards, Guidelines or Policies

When considering the organizational policies, vision and mission to cover principles in sustainable construction, it is evident that selected construction organizations have a considerable level of incorporation of sustainability concept into their vision, mission and policies. As stated by respondent CO4, "we have an H.S.C. (Health and Safety for Construction) policy, which is talking about the environment and long-term sustainability".

Also, it is identified that from inception, the ethos of sustainable development has resided within their mission and core values. Some has identified that minimizing ecological footprint has been a

continuous challenge and embarked on a journey which has been inspired by a more structured approach to sustainable development, guided by the principles of several international initiatives and bound by the Global Reporting Initiative (G.R.I.).

Another crucial factor that is fostering to achieve sustainability for construction organizations is that having a Quality Policy, Environmental Policy, Health and Safety Policy with a view of establishing lasting social, economic and environmental sustainability. Also, construction organizations are aligned with the ISO 14001 standards based on environmental management systems, and their practices are organized in order to corporate with the standards.

Sustainable Design

At the design stage, a decisive role is played by the client. As stated by CO4, "At the design stage, we consider customer's requirement and accordingly, structural design is done". Moreover, also, construction organizations propose environment-friendly proposals and continue them with the approval of the client. As per the data, it appears that construction organizations have relatively similar construction practices at the design stage. Most of the time, in the design stage construction organizations, are referred guidelines on LEED (Leadership in Energy and Environmental Design), G.B.C.S.L. (Green Building Council of Sri Lanka), UDA, if they have registered for such certification.

When considering the landscape designing, green shading using soft landscaping to shade windows from direct sunlight is the common practice of organizations. Also, to reduce heat, planting trees around the building and provide canopies have also been adapted.

The next significant factor in designing is energy usage. "All the buildings that we design should have energy efficiencies" (PR1).

Regarding energy minimization, the principal factors to be considered are reducing air condition usage, lighting and water usage. There should be a possibility of using less energy during the life cycle of the building, and the design has to be done accordingly. The practices that are used by the construction organization with regards to fulfilling that purpose can be listed as follows;

- Permitting maximum natural light and ventilation into the building is significant. When handling the ventilation of the building, the orientation of the building is considered. If the longest side is designed to face East, the inside temperature would be higher. Other essential things are windows to wall area ratio and shape of the building. Hence, they are considered in the design stage. Also, to reduce air condition cost, the buildings are designed in such a way that can capture the natural breeze and proper ventilation. There are types of Air Conditioners, with minimum power usage that can be imported, and those are recommended at the design stage. Appropriate glazing on windows to control heat transmission into the building and sensor-controlled lighting, L.E.D. bulbs are recommended at the design stage.

- "When you are planning a building with sustainable concepts, we need to consider the water efficiency as well" (PR1). To reduce the water usage at the end-use of the building is designed to adapt sensor tap fittings. Using harvested stormwater for toilet flushing is another practice adapted by construction organizations.

Accordingly, the building is designed to increase the indoor environmental quality, which is directly related to the health of the occupants utilizing optimizing energy and resource consumption. As

stated by CO1, "Line drawings and schematics are used in the design to minimize waste and optimize energy and resource consumption".

Sustainable Procurement

At the procurement stage, construction organizations purchase sustainable materials as decided at the design stage. Further, as stated by CO1, "Natural products for example sand, metal and blocks are bought only from environmentally friendly and ethical sources and timber, steel and aluminium waste brought down to near zero by the bulk ordering of cut lengths".

Sustainable procurement depends on the sustainability of the supply chain [3]. Accordingly, CO2 stated that "In our company, when selecting a supplier, we check how they are doing operations, whether they control environmental impact, what are the certificates, likewise we select them after an evaluation". Also, organization 1, (CO1) adopt practices like close monitoring of manufacturing processes of suppliers, evaluation of past performance with Triple Bottom Line in the selection of suppliers, undersupply chain integration.

Sustainable Technologies, Processes and Innovations

When examining the sustainable technologies, awareness of the 3R concept (Reduce, Reuse, Recycle) and usage can be noticed as the main factor.

"We reduce, delay, reuse and recycle construction waste" (CO1)

"At the construction stage, we use 3R" (CO3)

Moreover, the sustainable processes and technologies like rainwater harvesting, reusing, M.I.V.A.N. technology, using rammed earth walls for construction houses in rural areas also can be seen in the construction industry.

Material selection is also crucial in this case. Materials have to be decided for the designed building or while designing; it should be designed according to the relevant/selected material. Here the materials with the least environmental impact are selected by the construction organizations. Moreover, there is a review stage in some organizations where it is reviewed the usage of materials.

Using lightweight material is another significant factor in sustainable processes. As noted by PR6, "We use for high rise buildings a type of blocks; its density is 800 kg/m^3 which is floating on the water; normal bricks are heavier. Here the soil usage is lower. It saves natural resources. On the other hand, due to the reduction of weight, the usage of steel, concrete, the thickness for other structural components also reduced".
It can be identified as two main processes regarding lightweight material usage by reviewing the collected data;

- EPS panels (Expanded Polystyrene)

EPS panels are used instead of bricks and blocks to minimize the impact on the environment. These panels are energy saving as the heat transfer is very low, and therefore energy usage for air conditioning is also low. As noted by PR5, "We have used this for a building, and the temperature difference between inside and outside is 5^0C, that means if the outside temperature is 30^0C, inside temperature is 25^0C". Hence this method is sustainable economically as well as environmentally. The reduction of air conditioning cost will provide the benefit of cost reduction to the end-user of the building in terms of lifetime cost reduction.

- C.S.E.B. (Cement Stabilized Earth Blocks)

This can be used for load-bearing walls. The heat transfer is lower of the walls made by these C.S.E.B.s, and therefore A.C. usage is also lower.

Using alternatives or substitutes for materials which are depleting is a sustainable process that has also adopted in Sri Lanka, which is currently becoming popular. Under that, the primary material can be identified as M sand (Manufactured Sand) which is made using the dust of stone quarry as an alternative for river sand. Previously it was not allowed by designers to use it, but gradually it was used like 30% M sand and 70% river sand, and now there is even 100% M sand usage. As stated by CO3, "Sand is rare, and sand mining impacts the environment, so it is not sustainable. So, we use an alternative, M sand. It is a good sustainable practice. We have an M sand manufacturing plant. Sometimes we use 100% M sand for construction". The increase of using M sand will reduce the usage of river sand, which eventually will direct to reduce sand mining in rivers. This impacts the quality of the environment as well as environmental sustainability.

When considering the materials, using locally available materials is also an excellent sustainable practice adapted by construction organizations, whereas possible. For example, Thurulie, clothing factory of M.A.S. holding, has been used materials that were available in that area.

When the project is executing, construction organizations follow processes in a way that environmental impact is lessened. For instance, as stated by CO2, "There are regulations, we comply with them and assess whether they are complying. When the project is executing, we put controls to minimize the impact on the environment. We also monitor environmental parameters. There, first, we measure the parameters in the area before starting the project — for example, P.H. value of a water body near the site. Moreover, when the project is executing, we measure them. Then if there is a deviation, we can take actions, and if someone complains, we can check whether he or she is right or wrong.".

Waste disposal is also a critical process in executing the project. Construction organizations adopt sustainable practices in this case such as taking precautions to prevent illegal discharge of waste into groundwater, solid waste separation and disposing into dumping yards, timber off-cuts reusing as firewood by workers (CO1), measuring the amount of garbage taken out of the site, minimizing wastage by using resources economically and safeguarding materials from environmental impacts (CO4). CO2 handles waste through a waste management plan in which they identify the activities and the waste generated from each. As stated by the respondent of CO2, "Sometimes we have to get approval to dispose of hazardous waste. There are registered people/approved agents in C.E.A. to manage waste. We give our waste to them. Sometimes we pay and dispose of e-waste. That is mainly due to cooperate citizen responsibility".

Organizations that have obtained ISO 14001 certificate have specific procedures for environmental management such as waste segregation, waste minimization and Environment Aspect Impact Assessment (E.A.I.M.). A stated by CO2, "According to E.A.I.M., we first identify and list up the all the activities and their possible harms respectively. Then we give marks according to the criteria. Moreover, we identify the possible risks and set controls to those risks. Here we use Pareto Theory. We are doing periodical audits to check whether that requirement is compiled".

People and Organizational Structure

Under this category, it can be seen practices like, the hiring of skilled and unskilled staff from the local community (20% - 30%), recruitment of staff from the locality and retention through subcontractors (CO1), strengthening relationships with stakeholders and local communities through close dialogue and community projects (CO4).

A collaborative approach can be seen in Organization 4, as stated by their respondent (CO4), "We have to meet project targets. So, when it is difficult to find out the specific suppliers, products from the market, we negotiate with the consultant whether it is a GBCSL/LEED requirement, what is the minimum level of percentages allocated depending on the client's requirement and make a decision"

Sustainable Education and Training

Sustainable education and training practices adapted by construction organizations in order to increase the awareness of staff is considered in this section. Even though there are no significant steps have been taken for sustainable education increasing, there are some measures that have been taken for the training. As stated by CO4, "We do pieces of training at the very beginning and give awareness to all parties involved, and constantly we do in a sort of in-between ad hoc as well as planned programs. We train them from time to time. We can train them, but education has to be done at like technical colleges".

However, as stated by CO2, "We are doing continues training. We upgraded 14001 standards for 2015 version last year. Then throughout the organization, we did programs on how to adapt it. It mainly focused on the managerial level. Also, we are doing site-based programs to communicate identified risk control methods. We give internal training for labours. In every site, there is an officer who is responsible for the environmental management system. They have a separate training plan. Those officers are given external training, seminars".

Sustainable Measurements and Reporting

Sustainable measurements and reporting is not very much practice among construction organizations. There is a green rating system which is controlled by Green Building Council of Sri Lanka, and the

organizations that are registered for the green certificate under that are doing sustainable construction assessments.

Issues in Adaptation of sustainable Construction Practices

Through the examination of collected data, three significant issues in the adaptation of sustainable construction practices have emerged, namely,

- Awareness, attitude, training and education
- Legal framework and enforcement
- Availability of materials and suppliers
- Research and development of sustainable construction practices

Awareness, Attitude, Training and Education

The most significant issue in the adaptation of sustainable construction practices can be identified as a lack of awareness. In this case, it is not only a lack of awareness of labours but the lack of awareness of the entire society. As stated by the respondent of CO3, Awareness of labours is an issue, but before that, higher-level staff, management has to be aware. They have to understand the value". For instance, if we consider material selection, as stated by PR2 "In current normally it is used common materials that used in building construction. However, if we investigate on researches done, we can use materials that reduce life cycle impact, but the knowledge is low on that".

When the awareness of staff is lower, they just consider how to minimize the cost using traditional methods and do not use new technologies and not aware of how to be sustainable in construction. This leads them to ignore the low cost and environmentally friendly practices. In this case, labour awareness is essential as labours are the highest number of workers in a site. Therefore, no matter how good the plans are, there may be issues in execution.

Sustainability is based on practices. In that case, the awareness is necessary but not only the awareness of labours. If a company need to go for this concept, and if the top management has poor awareness, then the project will be failed. This can be formed as a rule or a guide and impose to labours, but not for management level. Therefore, awareness is essential from the management level. Also, the lack of clients who are aware of the sustainability concept is an issue as they have the dominant role in this case. Therefore, contractors should be able to inspire clients with the benefits of sustainable construction. For example, as stated by PR6, "EPS panels, there is a material saving, a better way to construct houses in rural areas, heat transfer is lower, and comfortability is higher, the cost is lower, but people do not accept because knowledge is lower".

The attitude of people is essential in adapting sustainability in any field. Even in the past, we used sustainable practices. However, now they have been given up and adapting practices from other countries as the minds of people are set to depend. Having the wrong concepts about sustainability is also a critical point. As stated by CO4, "Sometimes when we talk to a supplier, they might say that they are not using sustainable materials or percentage of using even though they use them. They think it is not a good thing".

Lack of training and education is also a barrier. Even though there are training programs in leading construction organizations, it might be rare in small-scale organizations. The education on sustainability concept is also a barrier as it has not yet become a core subject in schools, universities or technical institutes.

Legal Framework and Enforcement

The legal framework currently used is Blue Green Sri Lanka (Neela Haritha), Green Building guidelines for Sri Lanka. The main issue regarding this is that this is designed for new construction and not for already constructed buildings. Even though this can be used for

already constructed buildings, it would be difficult as the entire building has to end up with a massive change. Therefore, separate guidelines for old buildings to convert into this concept are needed.

Even though there is a guideline that applies to Sri Lanka, as per the opinions of professional, implementation is questionable, as noted by PR2, "Legal framework for the private sector is sufficient, but the enforcement is the thing that matters".

Waste disposal has become a significant issue in construction, and there is no proper procedure to dispose of some type of waste, especially hazardous waste like glass wool. Moreover, also lack standards to formulate the guidelines for the processes, and the materials that are identified as sustainable is another issue.

As well as the standards, incentives from the government are also less. As stated by PR7, "There must be incentives like tax concession and further even it is said to go for renewable energy, it is not a legal requirement, and so the enforcement is lower".

Availability of Materials and Suppliers

A construction has three targets; cost, time, quality. Hence, if it is needed to spend more time and cost to find materials, it would not be sustainable. Therefore, the lack of sustainable material in Sri Lanka has become one of the most significant barriers. As stated by CO4, "It is difficult to find F.S.C. certified timber in Sri Lanka". Besides the lack of materials, there is a monopoly for available materials as there are fewer suppliers in the market. Furthermore, the required quantity cannot be supplied by them.

When the suppliers are limited, the materials have to be imported, and it costs more due to the taxation which does not fulfil the economic sustainability. As stated by PR5, "We bought material about 25

million and the tax was 40 million. Even though we bought them because we wanted to establish EPS technology here, normally contractors do not compel to do so".

Research and Development of Sustainable Construction Practices

As agreed by all the professionals, research and development is a missing part of sustainable construction. As there are not sufficient innovations to improve sustainable construction, the adaptation has become lower as per the construction organizations considered, only one organization has a separate Research & Development unit. However, the organizations that have no separate Research & Development division, practise several innovative processes, as noted by CO2, "We do not have a separate unit for R & D, but we give innovative proposals to clients. Also, there are projects, plants, and internally there are innovations".

To go for sustainability, Research & Development is significant, but it is less in Sri Lanka, which has become a critical issue. As stated by PR3, "Sri Lanka is a country that applied the sustainable concept since very ancient time. However, there is no Research & Development even to find what sustainable practices were used in the past". Even though some researches are undertaking in the present for example by Sustainable Energy Authority, but the problem is they are not coming out in a way that can be used by professionals or construction industry.

Conclusion

There is a significant impact of the construction industry on environment, society and economy, which implies the need for adaptation of sustainable construction practices in the construction industry. This research was carried out on "Adaptability of Sustainable Construction Practices". Accordingly, the issues in the

adaptation of sustainable construction practices by construction organizations were aimed at identified by this research.

The analysis was done based on the framework proposed by Athapaththu & Karunasena (Athapaththu & Karunasena, 2016) by their study; "Framework for sustainable construction practices in Sri Lanka". Under each area, the analysis of data established the conclusions as follows.

Legal framework and enforcement

There is a legal framework in Sri Lanka for the rating of government and semi-government buildings which is compulsory for those, and also the private sector can apply, but it is not sufficient in the area of applying for the already constructed buildings. The enforcement of this legal framework is not also satisfying. Also, the legal framework in the areas of construction materials and waste disposal is not sufficient.

Sustainable construction standards, guidelines or policies

The analysis of the gathered data from the construction organizations claims that the construction organizations have organizational policies, visions and missions to cover principles in sustainable construction to some extent. However, it is not sufficient as their main intention is competitiveness based and profit-oriented.

Sustainable design

At the design stage, a decisive role is played by the client. However, the construction organizations adapt whatever possible sustainable designs within their organizational policies, visions and missions. The extracted practices are, permitting maximum natural light and ventilation into the buildings, practices that are increasing water efficiency level and reducing energy consumption.

Sustainable procurement

Organizational or institutional procedure for green supply chain management is considered here, and accordingly, the constructions organizations are not having a satisfying level of the procurement procedure.

Sustainable technologies, processes and innovations

Awareness of sustainable technologies, harmonization of academic and technical institutions and searching for cost-effective methods, sustainable construction evaluation criteria during tendering have been considered under this criterion. Accordingly, awareness on sustainable technologies and processes is genuinely high among higher-level staff but, harmonization of academic and technical institutions and searching for cost-effective methods, sustainable construction evaluation criteria during tendering are not in a considerable level. Notably, the harmonization with academic and technical institutions seems rare in the field.

6. People and organizational structure

Top management support and collaborative approach are coming under this criterion. Moreover, both these are practice in the construction organizations as per the analyzed data.

Sustainable education and training

As per the evidence, this criterion is insufficiently focused by construction organizations and also the government. Even though it can be seen the training programs conducted periodically, the education on sustainable concepts is not given as it is believed by the construction organizations that it is a responsibility of government. However, sustainable education given by the government is also inadequate, and analysis of data established the claim that it is unwise to neglect the sustainable education.

Sustainable measurements and reporting

Sustainable construction assessments by measuring and reporting sustainable constructions are not adapting much by construction organizations.

Accordingly, the below sustainable construction practices have been identified as the standard sustainable construction practices adopted in Sri Lanka.

1. Referring guidelines of LEED, G.B.C.S.L., UDA etc.
2. Using soft landscaping to shade windows from direct sunlight.
3. Permitting maximum natural light into the building by considering the orientation and shape of the building.
4. Designing buildings in such a way that can capture the natural breeze and proper ventilation.
5. Designing buildings to adapt sensor tap fittings and using harvested stormwater for toilet flushing for water efficiency of the building.
6. Lightweight material and alternative material usage.
7. Waste management in the construction stage.

The above practices show that there is a lack of sustainable construction practices in the procurement stage, sustainable training and education and sustainable measurement and reporting. However, as a whole, it can be concluded that construction organizations have passed the early stage of sustainable construction, but there are more to improve and develop.

As per the issues in the adaptation of sustainable construction practices, four main issues were identified namely,

1. Awareness, attitude, training and education
2. Legal framework and enforcement
3. Availability of materials and suppliers
4. Research and development of sustainable construction practices

One overriding fact that has emerged through the analysis is that cost is not a significant issue in the adaptation of sustainable construction practices. As per the construction organizations and professionals, the cost is not a barrier for adopting the sustainable concept.

As demonstrates by PR3, "The idea that the cost is higher in sustainable construction is a myth". Many sustainable practices can be adapted to lower cost. As it is difficult to achieve 100% level, if it is tried to achieve it, the probability of failure would be higher. Hence there are many practices below the 100% level that can be achieved with a lower cost. Also, if the will is there, it can become up with the cost-effective techniques on sustainable concepts as cost-effectiveness is a part of sustainability which reflects economic sustainability.

However, the cost is a bit higher than a conventional building, as stated by PR4, it is about 2% higher. However, the life cycle cost is lower. For instance, if double glazed windows are used for a building, the initial cost may be higher. However, overall, it reduces the life cycle cost by reducing energy consumption due to the reduction of air conditioner cost as the double-glazed windows control the heat transfer through the windows. In that case, the cost is not a significant issue which implies that, when considering the cost of sustainable construction, it should be considered the life cycle cost.

By taking the findings of the report into account, the following recommendations can be given.

As the lack of awareness has become a severe problem, in this case, actions should be taken to increase the awareness of the entire society. As stated by PR1, "We need to follow a top-down approach to educate people on sustainability". From the construction organizations' point of view; they should increase the training and

awareness programs and also the importance and benefits of sustainable construction must be driven into the minds of the clients.

As suggested by the professionals, the governing body of sustainable construction must be a non-profit and non-government organization. Moreover, also, the findings suggest that the government should take actions to provide incentives for the organizations that adopt sustainable construction practices to encourage them and attract other construction organizations.

Furthermore, there is some evidence to suggest that there must be programs for encouraging small-scale organizations to align with this concept.

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