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INVESTIGATION OF THE CHALLENGES OF EXECUTING SUSTAINABLE CONSTRUCTION PRACTICES IN THE SRI LANKAN CONSTRUCTION INDUSTRY

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ABSTRACT

The construction industry has made a significant contribution to global environmental issues while forging an imperishable relationship with society and the economy of the country. There has been an increasing trend in the promotion of sustainable construction (SC) in the industry. The implementation of SC practices is a vital step in construction projects to reduce the adverse impacts on the environment economy and society. While numerous challenges affect sustainable construction projects, those challenges continue to obstruct the further implementation of sustainable construction practices. However, the execution of SC projects in Sri Lanka is not up to an acceptable sufficient level due to many challenges. Hence, this research focused on the investigation of the challenges of executing SC practices in Sri Lanka. A quantitative research approach was adopted for the fruitful achievement of desired objectives. A questionnaire survey was designed to collect data and targeted 30 professionals including quantity surveyors, engineers, project managers, architects and other professionals in the industry. The results of the analysis revealed the importance and the existing applicability of SC practices in Sri Lanka. However, the results show that the important SC practices in Sri Lanka do not apply to a sufficient level in the Sri Lankan industry. Lack of government support, increasing energy costs and lack of existing SC principles are the major challenges to the SC in Sri Lanka. Finally, the findings recommended further improvement of SC practices in Sri Lanka with the perspective of legal, educational, technical, and financial efforts.

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

1. INTRODUCTION

The construction industry is one of the major industries that significantly contribute to the growth and economy of the world (Wong & Vimonsatit, 2012). Tripathi and Jha (2019) stated that it is the second-largest industry, in terms of providing employment opportunities. The construction industry is a service industry that performs the planning,

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designing, construction, alteration, refurbishment, maintenance, repair, and demolition of structures as part of a nation's economy (Towey, 2017). Sustainable construction (SC) is a strategy for achieving sustainable development, which is one of the needs of the construction industry (Osuizugbo et al., 2020). Therefore, SC is a very important step in the construction industry.

When it comes to implementing SC practices, there are several challenges to be overcome. SC is a way to ensure that all construction activities are carried out sustainably, from planning to completion, while also considering economic and social factors as well as environmental impacts (Ismail, et al., 2016). Durdyev, et al. (2018); Tokbolat, et al. (2020) recognised that concerns about the cost premium of SC, as well as a lack of knowledge and awareness, have been reported as the most significant challenges, leading to a reluctance to implement the SC concept, particularly in developing countries. Even though SC practices are necessary to the industry, according to Willar et al. (2021), challenges to the execution of new practices, such as SC are constantly present. Moreover, Khalil et al. (2021) presented the challenges confronted by the construction industry in Libya while integrating sustainable practices. It indicates the complexity of implementing sustainable construction practices in the current context. In the Sri Lankan context, there are many construction projects underway hence attention needs to be paid to the SC. Palliyaguru, et al. (2018) also accept that sustainable development has typically been concerning the urban areas, urban populations, and urban issues in Sri Lanka. Furthermore, Jayalath and Gunawardhana (2017) stated that there are many challenges faced by the construction industry in Sri Lanka such as the high cost of construction materials, lack of skilled workers, pollution, delays in land acquisition, and frequent changes in regulations which could affect the SC practices.

According to Tokbolat et al. (2020), the majority of SC practices are environmentally related. However, environmentally sustainable practices are rarely executed in Sri Lanka. Although Sri Lanka has a few SC practices existing, some of them have challenges during their implementation. Therefore, it is important to investigate the challenges of executing sustainable construction practices in Sri Lanka. Hence, this research focuses on SC in the Sri Lankan context and the challenges of executing SC in the Sri Lankan construction industry.

2. LITERATURE REVIEW

2.1 SUSTAINABLE CONSTRUCTION PRACTICES

Sustainability is a challenging task, and it necessitates decision-makers flexibility and willingness to change their approaches (Hussin et al. 2013). Further, the authors stated that it is critical to balance the key elements of sustainability, including the environment, economics, and social aspects, to accomplish sustainable building. As cited by Hussin et al. (2013), SC practices can be implemented at any point during the construction process, from design to demolition. Further, Hussin et al. (2013) cited that the impact of the built environment should be addressed on a life cycle basis, from the origins of the building material, through the manufacture and installation of these materials, to their eventual demolition of the building.

Many authors conducted their surveys on many SC practices which are currently executed in the industry. Table 1 provides a summary of such indicated SC practices and how the authors contributed.

Table 1: Sustainable construction practices in the global industry

Sustainable construction practice/s	Author/s
Introduce Green building codes	Saleh and Alalouch (2015)
Green building bonds	Howe and Gerrard (2010)
Minimise resource consumption Maximum resource reuse Usage of renewable and recyclable resources Comply with prevention of air pollution regulations Create a healthy and non-toxic built environment	Tan et al. (2011)
Construction waste management	Ismam and Ismail (2014); Madurwar et al. (2013); Hussin et al. (2013); Mega (2010); Letcher and Vallero (2011); Saadi, et al. (2016)
Recycling of concrete	Senaratne et al. (2017)
Energy management	Madurwar et al. (2013); Shan et al. (2017)
Generate electricity from renewable sources	Strielkowski et al. (2017)

According to Table 1, majority of the research, scholars have discussed construction waste management as a sustainable construction practice. Furthermore, updated literature findings are emphasising the recycling of concrete and the generation of electricity via renewable sources. Moreover, the industry had taken several practical actions to encourage the development of SC practices as buildings constructed with ecology gives benefit from lower operating, development, and maintenance costs as well as improved durability. Those practices should be incorporated into construction strategies. Construction firms had to change their strategies to incorporate SC practices into their operations because it focused on the industry as legislators, employers, building users and investors become more aware of the environment (Aigbavboa et al. 2017).

2.2 APPLICABLE SUSTAINABLE CONSTRUCTION PRACTICES FOR SRI LANKAN INDUSTRY

Senaratne et al. (2017) stated that the necessity to recycle building and demolition waste, in particular, has grown critical as concrete is the most common building and demolition waste, and aggregate is the most common by-product of recycled aggregate concrete, the greater use of recycled aggregate has been investigated to promote more SC practices. Kariyawasam and Jayasinghe (2016) said that it is critical to think about how to avoid undesirable features of soil and obtain strong, long-lasting, and ecologically friendly building materials. Instead of recycling and reusing existing materials, natural resources are being consumed at an alarming rate to produce new construction materials (Senaratne et al. 2017). The author further stated that to achieve sustainability in the construction industry, the requirement of recycling construction and demolition waste had become a vital aspect. The requirement to become sustainable for the construction industry has become specious with the construction industry being a huge consumer of natural resources (Luhar & Luhar, 2019). The use of recycled aggregate in concrete is a sustainable and economical alternative to natural aggregate

and is also effective for non-structural components where strength is not critical (Devi et al., 2021).

Another SC practice was identified to ensure that value is delivered to the project most effectively; the systematic process of value management can be simply divided into three main phases, namely value planning, value engineering and value analysis (Karunasena, et al. 2016). The authors further suggested that the SC team will be led by an architect, while the value planning team will be led by a quantity surveyor. The above concepts are easily applicable to the Sri Lankan construction industry.

Senanayake and Chandanie (2021) stated that more emphasis should be placed on the use of environmental, social, and economic assessments when implementing a construction project, especially at the feasibility stage. According to the authors, tax policy, project scope, scale, and functions, location advantage, the influence of domestic product and resource use policy, technology advantage, market competition, fluctuation in foreign currency, regulation in export and import restrictions, influence in domestic products and resource use policy, and budget estimate are the most critical factors to considered under economic sustainability requirements.

Green BIM technology is a significant innovation that emerged from the integration of BIM with sustainable strategies, enhancing the sustainable growth of buildings while providing better opportunities to improve green building performance (Rathnasiri, et al. 2017).

2.3 SUITABLE SUSTAINABLE CONSTRUCTION PRACTICES FOR THE SRI LANKAN INDUSTRY

Heralova (2017) stated that the sustainability performance of an individual construction project across its life cycle is a vital aspect in attaining the goal of sustainability. Waidyasekara and Fernando (2012) stated that the "Green Building" movement emerged, which later gained traction as a result of the concept of sustainability. Rathnasiri et al. (2017) supported this statement by saying that green buildings provide several benefits for building owners and users. The Sri Lankan government has already established many policies to encourage local green growth (Karunasena and Thalpage 2016). The successful implementation of SC methods is essential to address environmental issues in developing countries. According to Karunasena, et al. (2016), all experts agree that the SC and value planning concepts should be implemented at a higher level in the Sri Lankan construction industry than it is existing.

All experts agree that the SC and value planning concepts should be implemented at a higher level in the Sri Lankan construction industry than is existing. Experts agree that both of these principles should be utilised as early as possible, preferably at the planning stage of a project, because all of these stages are covered at the planning level. According to the finding of (Senanayake and Chandanie 2021), experts pointed out that tax policy should be conducted under any framework and that the government should provide tax concessions and subsidies to projects that encourage SC.

The introduction of recycled concrete to the market is a revolutionary approach (Senaratne et al. 2017). Therefore, quality and consistency could be closely regulated. Furthermore, practitioners, on the other hand, were inspired by the long-term benefits and argued that structures made of recycled aggregate could achieve a higher green rating and it was especially suggested for government projects and those requiring a

high level of environmental sensitivity. While focusing on the research conducted by Senaratne et al. (2017), recycling of construction and demolition waste is becoming paramount as well as those wastes have added to SC practices. Those authors supported this statement by referring to the usage of natural and recycled aggregates. However, the above authors said that towards the sustainability of the industry, recycled aggregate must be widely used and even the natural aggregates must be replaced.

Table 2 classifies the SC practices applicable to the Sri Lankan construction industry.

Table 2: Classification of sustainable construction practices for the Sri Lankan industry

Sustainable construction practices applicable for Sri Lanka	Reference/s
Use of ecologically friendly building materials	Kariyawasam and Jayasinghe (2016)
Recycling of aggregate in concrete, Necessity of recycling building and demolition waste	Senaratne et al. (2017)
Using a systematic process of value management for sustainable construction	Karunasena, et al. (2016)
Use of environmental, social, and economic assessment on sustainable construction, Implement sustainable construction and value planning concept	Senanayake and Chandanie (2021)
Green BIM technology	Rathnasiri et al. (2017)
Green building movement	Waidyasekara and Fernando (2012)
Enforcement of policies to encourage green growth	Karunasena and Thalpage (2016)

2.4 CHALLENGES WHEN EXECUTING SUSTAINABLE CONSTRUCTION PRACTICES IN SRI LANKA

Construction activity is commonly considered to have adverse impacts on the environment, which is the basis of sustainable development for human beings (Senanayake and Chandanie 2021). Jayalath and Gunawardhana (2017) said that the Sri Lankan construction industry has not taken enough action to remedy the present issues that face the construction industry.

Table 3 provides a summary of the challenges when implementing SC practices in Sri Lankan construction. Sustainability in construction is a challenging task for contractors due to diminishing natural resources and increasing energy costs (Athapaththu and Karunasena 2018). Senaratne et al. (2017) identified that the use of recycled aggregate has been discovered to lead to a sustainable future by generating an alternative to the use of traditional natural concrete. However, the authors said that the research on recycled aggregate has found limiting factors to the use of materials due to its shortcomings related to its low strength.

Table 3: Challenges to implementing sustainable construction in Sri Lanka

Identified Challenges	Source
Diminishing natural resources, not following sustainable construction procedures	[1]
Shortcomings due to law strength of sustainable construction materials	[2]
Lack of sustainable construction principles in the Sri Lankan Industry	[3]
Unstable developing activities due to the environmental, social, and economic challenges	[1]

Identified Challenges	Source
Complexity, an increase in the cost of construction projects, risks, and the mindset of stakeholders	[4]
Lack of client awareness of SC, sustainable design costing, lack of government support, and shortages of value planning proposals on sustainable construction.	[4]
Lack of legislation and regulations on sustainable construction	[5]
Inherent capabilities of Green BIM technology	[6]

Sources: [1] Athapaththu and Karunasena (2018); [2] Senaratne et al. (2017); [3] Senanayake and Chandanie (2021); [4] Karunasena, et al. (2016); [5] Hewage and Indrani (2011); [6] Rathnasiri et al. (2017)

The research findings of Athapaththu and Karunasena (2018) argued that contracting organisations based in Sri Lanka do not follow existing SC procedures. This is confirmed by Senanayake and Chandanie (2021) by reporting that there is no guidance for implementing sustainable development principles in the construction industry. Karunasena, et al. (2016) reported some challenges within the industry by stating that there is no standard or consistent process for both SC and value planning applications in the Sri Lankan construction industry.

The nation continues to struggle with not only environmental but also economic and social challenges as a result of the country's unstable development activities over the years (Karunasena, et al. 2016). As resources become scarcer, social, environmental, and economic sustainability is becoming increasingly important (Karunasena, et al. 2016). Because of those risks and mindsets of stakeholders, SC practices are implemented very lower. Even though that is stated, Karunasena, et al. (2016) said that employers, clients, contractors, consultants, the government, and all other stakeholders in the industry have a significant responsibility to work toward efficient design, construction, and upkeep of the built environment using sustainable techniques.

Some major challenges according to Karunasena, et al. (2016) the execution of SC practices; lack of client awareness of SC, sustainable designs costing more than regular designs when considering initial costs, lack of government support, more time-consuming at the initial stage of design, less knowledge of sustainability, consultants not coming up with sustainable and value planning proposals, shortage of value planning proposals were identified as challenges and drawbacks for SC. Similar to the above statement, Hewage and Indrani (2011) reported that in comparison to environmental protection, there is a lack of legislation and regulations in Sri Lanka that directly affect sustainability practices. Finally, releasing the developed project feasibility criteria as a sustainability guideline as project clearance will improve Sri Lankan green building practices.

When considering BIM technology for the Sri Lankan construction industry, Rathnasiri et al. (2017) reported that the inherent capabilities of green BIM technology are hidden and invisible in the Sri Lankan context because BIM has not yet been implemented in building construction, operation, and maintenance. As a result of this, the authors further stated that an effort is required to encourage and demonstrate the value of Green BIM technology for green building practitioners.

3. METHODOLOGY

3.1 RESEARCH DESIGN

According to Kothari (2004), a research design is a conceptual assembly based on which the whole research shall be conducted, in which the data shall be collected and analysed for the sake of achieving the aim of the work. The author further said that the function of research design is to obtain relevant evidence with the least amount of effort, time, and money possible. Research design guides the ultimate target of achieving the research objectives.

3.2 RESEARCH PROCESS

Abu-Dalbouh (2013) demonstrates the different steps, which were followed during the research process to proceed with research with problem exploration, data collection, and analysis. The research problem was thereafter grounded within literature to formulate the research problem of this study. Further, adhering to the following sequential process, helped to avoid errors and attain the expected results.

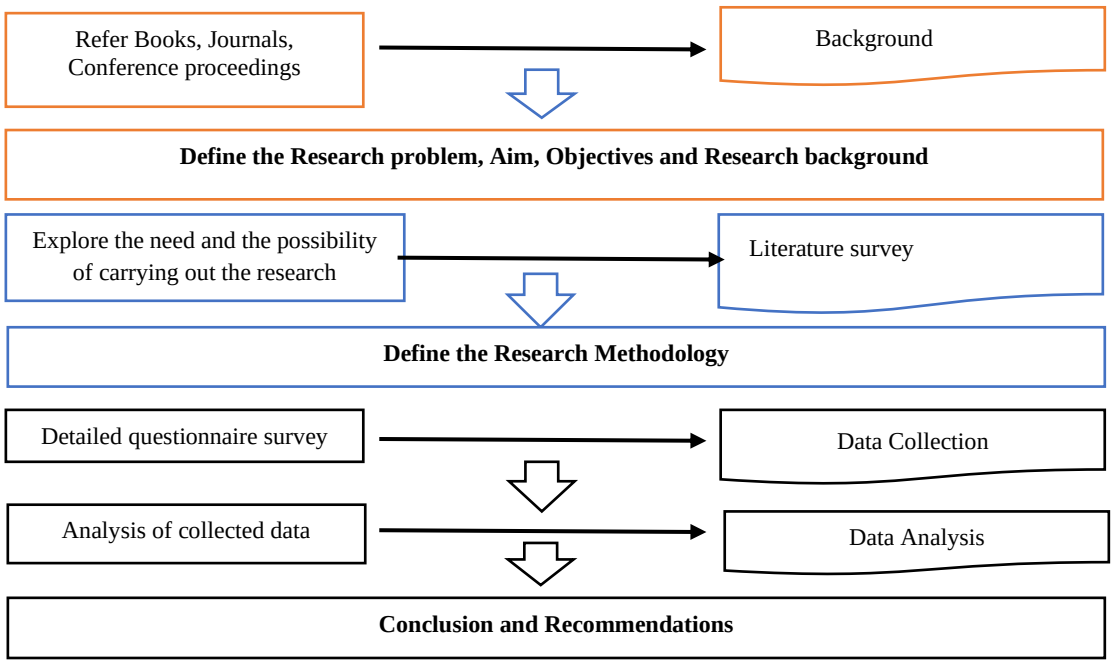

Figure 1: Research process

3.3 RESEARCH APPROACH

According to the definitions and comparison of the above research approaches, it was decided to choose a quantitative research approach for this study. This research purposes to address the problem challenging factors of executing sustainable knowledge in the Construction industry in Sri Lanka, to identify the challenging factors of executing sustainable knowledge in the construction industry in Sri Lanka, it requires in-depth inquiry to gather information related to applications and executions of SC practices in the Sri Lankan industry. To achieve the expected results of this study all the information associated with SC projects in Sri Lanka has to be investigated. Therefore, a quantitative research approach was facilitated here in this research to go through practical aspects broadly.

3.4 RESEARCH STRATEGY

Among these research strategies survey method had been chosen as the most appropriate strategy for this research due to the following reasons. The study under consideration is required to gain opinions regarding the challenges of executing SC knowledge in the Sri Lankan construction industry. Further, the identification of SC practices and procedures to be followed when providing SC knowledge in construction projects was another focus of the research. Hence, a survey strategy was used during the data collection.

3.5 DATA COLLECTION

The common data collection methods include interviews, questionnaire surveys, documentary review, observations, and audio-visual materials. To collect the data on overall project performance, some of the critical factors identified were used in the questionnaire. To achieve the objectives of this research, a detailed questionnaire survey was selected as the data collection technique. In the quantitative approach, a set of questionnaires that contains the number of questions is sent to the required professionals in the industry. Using data collection techniques to gain the essential details to establish the research problem, a questionnaire survey was developed based on the literature review with the "Likert scale" since the SC procedures in construction projects in Sri Lanka were some projects with different challenges. Table 4 shows the profile of the respondents illustrating their experience and involvement in the construction industry.

Table 4: Profile of the respondents

Category	Inclusive groups	Respondents
Type of occupation	Quantity Surveyor	60.00%
	Project Manager	16.70%
	Engineer	13.30%
	Architect	6.70%
	Safety Officer	3.30%
Level of Experience	Less than 01 year	20.00%
	Between 01 – 05	66.70%
	Between 06 – 10	13.30%
Education Level	Bachelor's degree	77.00%
	Master's degree	10.00%
	Diploma	13.00%

The above data illustrates that the majority of the respondents are quantity surveyors with between 1-5 years of industry experience. Furthermore, more than two-thirds of the respondents are with bachelor's degree as the highest educational qualification.

3.6 DATA ANALYSIS

Data analysis after data collection is influenced by the expected result of the research. SPSS, Excel software used to analyse the quantitative data gathered from the questionnaire survey. The Likert scale responses should be in a specified order in which the respondent's preferred answer is chosen. For the analysis of quantitative data

collected through the questionnaire survey, the Relative Important Index (RII) technique was used, and Excel was used to calculate RII.

4. DATA ANALYSIS

4.1 COMPARISON ANALYSIS OF LEVEL OF IMPORTANCE AND EXISTING APPLICATION OF SC PRACTICES

Table 5 introduces the sustainable practice terminologies used for the research. The RII value was generated through the questionnaire survey responses obtained from 58 professionals. Table 5 comparatively presents the RII value for each sustainable practice considering their importance and existence in the construction industry. It gives an understanding to the reader of the key focus areas of sustainable practice from practical and theoretical perspectives.

Table 5: Comparison of application and importance of sustainable construction practices in Sri Lanka

Ref	Sustainable practice	RII for Application of SC	RII for Importance of SC
SP3	Minimise resource consumption	0.7067	0.9133
SP8	Energy management	0.7067	0.8600
SP11	Use of Ecological friendly building materials	0.6667	0.8866
SP5	Using recyclable resources	0.6600	0.9000
SP10	Enforcement of policies to encourage green growth	0.6533	0.8600
SP1	Using green building codes	0.6467	0.8666
SP4	Using Renewable resources	0.6467	0.9400
SP6	Construction Waste Management	0.6267	0.8733
SP2	Using Green Building Bonds	0.6200	0.8000
SP9	Green BIM technology	0.6000	0.7866
SP7	Recycling of concrete	0.5267	0.8133

Responders are asked to rate the SC practices according to the level of importance and level of the existing application in the Sri Lankan industry. Figure 2 depicts the comparison of the overall mean value of each SC practice based on parameters of importance and application in the industry. Furthermore, the illustration of the gap between 2 parameters (importance and existing application) signifies the areas which are lacking in the Sri Lankan construction industry.

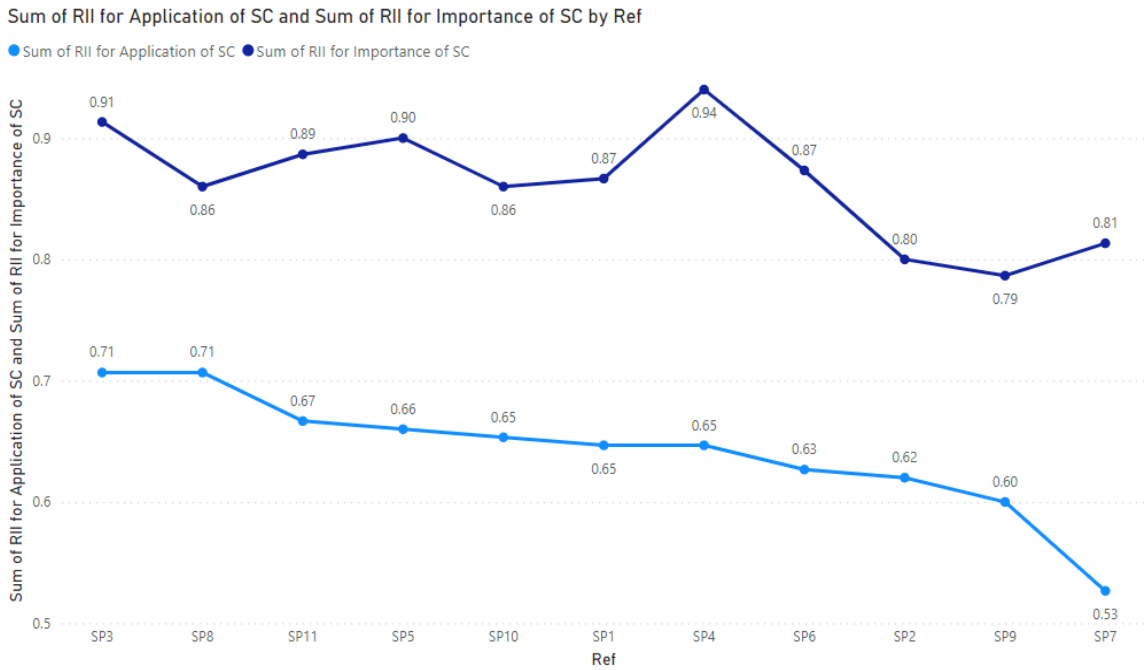

Figure 2: Comparison between the importance and application of SC practices in the SL industry

According to Figure 2, it illustrated SP4 achieved the highest mean value (4.70) for "level of importance to Sri Lanka". Then the second highest mean value (4.57) is archived by SP3. All the SC practices received a mean value of or above 4.00. That means those are "important" to the Sri Lankan industry according to the Likert scale. The mean value of SP4 and SP3 for "application of SC practices within the existing industry" are respectively 3.23 and 3.5. Even though SP4 and SP3 received the highest mean values for "importance to the SL industry", they received mean values of 3.23 and 3.50 respectively for "existing application in the SL industry".

Except for SP7, all other SC practices received on or above 3.00 for mean value. That indicates that even though all the SC practices can be considered as "important" to the SL industry, application within the existing industry of those SC practices is "Sometimes", according to the used Likert scale. Only SP7 can be depicted as "rarely applying" within the SL industry even though it ranked as an "important SC practice" to the SL industry. Furthermore, SP2 has the lowest gap among all the sustainable construction practices based on their existence and their importance as an SC practice.

Baloi (2003) agreed that the minimise resource consumption (SP3), using recyclable resources (SP5) and using renewable resources (SP4) are important SC practices. Additionally, Baloi (2003) presented that protection of the natural environment, creation of a quality-built environment, and a healthy and non-toxic environment are the main principles of sustainable construction, which is known as the SC practices. However, compliance with sustainability, design and procurement, technology and innovation, organisational structure and process, education and training, and measurement and reporting are presented as the SC practices by Tan, et al. (2011), which were not identified in this research. Hence, there is a variety of SC practices and their availability and importance in the Sri Lankan context. Hence, the importance of SC practices in the construction industry is varying based on the country. The research findings have presented the unique SC practices in Sri Lanka compared to previous research studies.

4.2 RECOMMENDATIONS TO FURTHER IMPROVE THE SUSTAINABLE CONSTRUCTION PRACTICES IN THE SRI LANKAN INDUSTRY

Findings that had been obtained from the questionnaire survey had been categorised according to the efforts. To implement SC practices in Sri Lanka, there should be influence from many sides. Those efforts are considered legal, educational, technical, and financial efforts. Figure 3 presents the efforts in which the obtained recommendations were categorised.

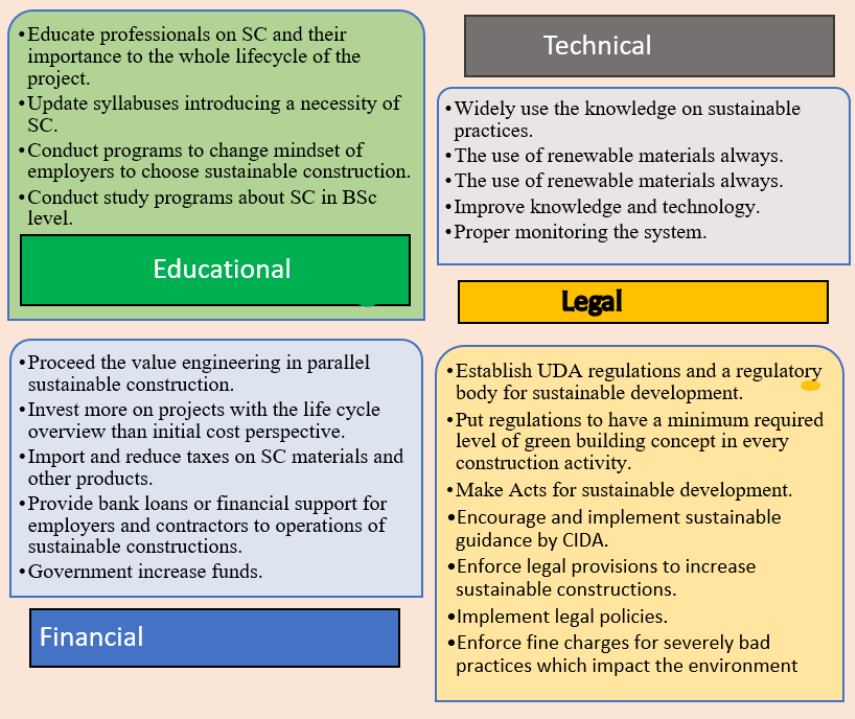

Figure 3: Recommendations to further improve the SC practices in Sri Lanka

According to Figure 4 the combination of legal, technical, educational, and financial efforts the SC practices are intended to implement in Sri Lanka. Athapaththu and Karunasena (2018) have presented a framework inclusive above finding in Figure 4 confirming the importance of these factors for the implementation of SC practices in Sri Lanka. Hence, the above 4 factors are ideal to implement SC practices in Sri Lanka. Additionally, standards, guidelines and policies are vital considerations that help the improvement of SC practices in Sri Lanka (Athapaththu, et al. 2016).

5. CONCLUSIONS

Although Sri Lanka lacks adequate SC methods, there is a great need for SC as a developing country. SC practices are the "use of ecologically friendly building materials, recycling of aggregate in concrete, the necessity of recycling of building and demolition waste, using a systematic process of value management for SC, Use of environmental, social, economic assessment on SC, Implementing SC and value planning concept, Green BIM technology, Green building movement, Enforcement of policies to encourage green growth".

The construction industry has a huge environmental impact, consumes huge energy and the construction industry is conversely depleting of natural resources. Therefore, the SC

is important for environmental protection. Globally identified SC practices were subjected to identify the level of importance and applicability. Those SC practices are "Introduce green building codes, green building bonds, minimise resource consumption, maximum resource reuse, usage of renewable and recyclable resources, comply with prevention of air pollution regulations, create a healthy and non-toxic built environment, construction waste management, recycling of concrete, energy management and generate electricity by renewable sources". All the SC practices were identified as "Important" SC practices to Sri Lanka. Even if the result is like that, "recycling of concrete" observed as "rarely" applicable while others observed as "sometimes" applicable in construction projects in Sri Lanka.

Diminishing natural resources, increasing energy cost, not following SC procedures, Shortcoming due to low strength of SC materials, lack of SC principles in Sri Lanka, unstable developing activities due to environmental challenges, Unstable developing activities due to social challenges, Unstable developing activities due to economic challenges, the complexity of projects, mindset of stakeholders, lack of clients awareness of SC, lack of government support, Sustainable design costing, high time consuming, less knowledge on SC, shortages of value planning proposals on SC, lack of legislation and regulations on SC, inherent capabilities of Green BIM, and technology challenges are challenges for executing sustainable practices in Sri Lankan construction industry.

Adhere to a proper plan from the inception until the completion of a project, improve Knowledge of SC practices among stakeholders, improve rules and regulations on SC by the Government, increase the awareness of the community on SC, move to use green construction materials and implement an effective waste management plan, rate contractors according to their bias about involving sustainable projects/using a ranking method on SC for Contractors were mainly identified strategies to overcome the challenges for executing sustainable construction practices in Sri Lanka. The adaptability of those identified strategies to the Sri Lankan context was investigated by the questionnaire survey.

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