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## Minimise Cost Overrun Using Sustainable Construction Materials in Sri Lankan Construction Industry

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## **Minimise Cost Overrun Using Sustainable Construction Materials in Sri Lankan Construction Industry**

### **Cover Page Footnote**

The authors would like to thank the industry experts who have actively participated in the surveys, interviews and discussions for this study.

# Minimise Cost Overrun Using Sustainable Construction Materials in Sri Lankan Construction Industry

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## Abstract

A successful construction project is determined when it is completed within the expected budget and time, ensuring the required levels of quality and safety. For a project to be successful, it is essential to plan properly and have a reliable monitoring system in place. Furthermore, the building construction sector has a negative impact on the environment by generating waste, increasing carbon emissions, polluting the air and water, and accelerating climate change. This study intends to investigate cost overrun prevention strategies in Sri Lanka using sustainable building materials. Accordingly, a mixed-method research approach was selected, and an e-based closed-ended questionnaire survey and semi-structured expert interviews were carried out to collect data from construction industry professionals. In the questionnaire survey, a total of 80 construction industry experts were selected from different job categories as the respondents, and 53 responses were received with a response rate of 66.25%. On the other hand, 10 construction professionals participated in the semi-structured interview. The study has identified 15 factors that significantly impact cost overrun in the Sri Lankan building construction sector based on the mean weight ratings. The study found that using sustainable alternatives to natural

resources at a lower cost is preferable. The most workable solutions to control the identified critical factors were determined to be new policies for sustainable construction, new financial frameworks for importing sustainable materials, new construction methods and technologies associated with sustainable materials and controlling the monopoly of sustainable material suppliers or manufacturers.

**Keywords:** *Construction industry, Cost overrun, Sustainability, Sustainable material, Sri Lanka*

## 1. Introduction

The construction sector is placed in a critical state in terms of boosting the commercial development of a state (Ahady, Gupta, & Malik, 2017). In recent years, the construction sector has made its way to the top leaders among other industries (Thabani, 2019). The ever-rising complications of construction projects illustrate that construction managers have an increasing need to complete the project within time, cost and quality parameters as agreed in a study on reviewing cost overruns in construction projects (Vaardini, Karthiyayini, & Ezhilmathi, 2016). However, poor cost management practices in a project have been a major concern among the construction project stakeholders

(Saleh, 2008). On the other hand, Thanushan (2012) stated that the accuracy level of estimation helps to minimise the risks associated with cost performance in the construction industry. According to Hammed, Ismail, and Mohd (2010), cost implications are considered the most common problems in global construction projects, and more studies are needed to improve this problem in the future. This issue can be seen in most developing countries, where the initial budget cost may exceed 100% (Shah, 2016).

There are three basic categories for cost control in a construction scenario, namely resource planning, cost estimation, and cost control and budgeting (Aram, Eastman, & Beetz, 2014). Furthermore, under cash flow management, project accounting can be used to further clarify cost control (Chigara, Moyo, & Fungai, 2013). This can be used to identify the final cost of any particular project in the aspects of time, cost, quality as well as the scope for future forecasts (Ali & Kamaruzzaman, 2010). In nations like Sri Lanka, the construction industry is under pressure to reduce prices due to the high demand for new buildings and limited public financing supplies (Vinishya, 2021). The issue of rising construction prices is becoming apparent in many facets of construction (Hiroshan & Hadiwattege, 2014). Many contractors struggle to make the project lucrative and safe for themselves, and this poses a number of other issues that affect all parties involved (Malkanathi, et al., 2017). Patel et al. (2016) investigated on underlying reason and effects of cost overrun on building construction projects, and the study revealed that underestimation of cost and length of delays, the effect of geological risks, lack of knowledge about changes in exchange, environmental risk, lack of knowledge on project planning and complexity of the project and lack of decision making by key stakeholders are the

main key causations of cost overrun on building construction projects. Furthermore, in many developing countries, not all factors are similar to all projects in developing countries, but there are general factors such as poor management, inaccurate material price fluctuations and contract financial status. It became clear that the cost was exceeded (Ahady, et al., 2017).

The global construction sector contributes significantly to environmental deterioration and pollution as well as to global warming. Climate change, mostly caused by greenhouse gases, has recently become a significant issue to the whole biosphere (Hannigan, et al., 2016). The global need for sustainable development exerts enormous pressure on the building sector to promote sustainable construction techniques (Akadiri, 2015). To reach ultimate sustainable aims, sustainable buildings may bring environmental responsibility, social awareness and economic profitability objectives to the fore in the built environment and amenities for the larger community (Ali & Nsairat, 2009). Sri Lankan history demonstrates how our forefathers built great cities, irrigation systems and religious monuments that coexisted with nature while providing citizens with a sustainable economy and lifestyle (Green Building Council Sri Lanka, 2010). However, as a result of unsustainable development over the past decades and continuing today, Sri Lanka suffers from not only environmental aspects but also economic and social issues (Sandanayake, Zhang, Setunge, & Thomas, 2014). According to Hussin et al (2013), one of the main benefits of applying sustainable material is minimising the cost of

construction projects and providing more economical benefits to the project. Yet, the Sri Lankan construction industry struggling to adopt green features construction methods due to various challenges (Kushani & Karunasena, 2018). Therefore, this study intends to minimise cost overrun using sustainable construction materials in the Sri Lankan construction industry.

## **2. Materials and Method**

### **2.1 Materials**

#### **2.1.1 Growth of Sri Lankan Construction Industry and Sustainable Development**

The construction sector is one in which many stakeholders are involved, and many resources are used (Ramachandra, Geekiyanage, & Perera, 2016). Construction is an industry that involves the manipulation of a variety of resources and building is an industry with several players (Aram, Eastman, & Beetz, 2014). Furthermore, for the construction project to be successful, many organisations such as the employer, consultancy team, contractor, subcontractors, and supplier organisations are required. These firms must communicate information during the procurement process to produce strong teamwork and complete a successful project in terms of time, cost and quality (Niknam & Karshenas, 2015). The construction sector in Sri Lanka accounts for 7.6 percent of the country's Gross Domestic Product (GDP) and is recognised as one of the country's primary drivers of economic development (Central Bank of Sri Lanka, 2020). The building business encompasses anything from single-family homes to massive infrastructures such as motorways and multi-story skyscrapers (Madushanka & Tilaksiri, 2020). Every year, a large amount of money is set aside in Sri Lanka for construction-related operations. Donors cover 90% of the cost of road development

in Sri Lanka (Mohamed, De Silva, & Waiydasekara, 2021). However, in Sri Lanka, most of the construction works have been affected by the environment in a negative way (Sandanayake, Zhang, Setunge, & Thomas, 2014).

Nevertheless, the Sri Lanka Green Building Council has demonstrated its commitment to this sustainable growth by implementing green building ideas and principles (Green Building Council of Sri Lanka, 2018). The Green Building System is a technique for reviewing and converting a building's design, construction, and operation. The design of this green building idea should have an influence on the entire system, beginning with the infrastructure (Dissanayake, 2015). The body of the green building preserves processing stages that contribute to the structure's outer life span. It is the difference between rising and lowering manufacturing and providing. It involves the production of all resources, regardless of whether they are used in a green project. As a result of the breadth of green buildings, a multidisciplinary approach is required (Green Building Council of Sri Lanka, 2018). GBCSL was found in 2009 by a group of engineers, architects, quantity surveyors, structural engineers, university academics, town and country planners, environmentalists, business leaders and construction industry leaders as Sri Lanka's leading authority on implementing green building practices and concepts (Jayasekara, 2017). The GBCSL is a non-profit organisation built on consensus, with representation from all facets of the real estate business. GBCSL's mission is to reform the Sri Lankan construction industry and achieve total sustainability for our environment, society, and economy in order to guarantee the world's future security (Green Building Council of Sri Lanka, 2018).

### 2.1.2 Causes of Cost Overrun in Construction Sector

Australia, Malaysia and Ghana were used in an investigation to identify the causes of cost overruns and delays in the construction industry by Shah (2016). In Australia, deficiencies in both planning and scheduling, construction methods, effective monitoring and processes for feedback are the main factors. In the context of Ghana, the factors differed in payment certificate delays, underestimation of the cost of the project, project size and complexity. Cost overruns and delays occurred in the Malaysian construction industry. In Ghana due to inadequate planning by the Contractor, weak management at the site and lack of experience by the Contractor (Shah,2016). In addition to that Azhar, et al. (2008) carried out some research on the Pakistan construction industry and found that variations in prices of raw materials, variations in prices of manufactured materials, high machinery costs, poor cost and site management, interruptions in phases between designing and procurement, use of poor and inaccurate cost estimation tools, improper planning coupled with additional work as well as government policies with unsupportive frameworks.

However, Muhammad, et al. (2018) conducted the same research done by Shah (2016) and Azhar et al. (2008) but in the Malaysian building construction industry and that study revealed deficiencies in both planning and scheduling, construction methods, lack of effect on monitoring and processes for feedback, payment certificate delays, underestimation of the cost of the project, project size and complexity, weak management at site, lack of experience by the contractor, variation of prices of raw materials, variation in prices of manufactured materials and high machinery was the main causations that increase the

project cost in the Malaysian construction industry. According to Thabani (2019) study showed a lack of experience by the contractor, variation of prices of raw materials, variation in prices of manufactured materials, high machinery costs, interruptions in phases between designing and procurement, use of poor and inaccurate cost estimation tools, government policies with unsupportive frameworks, and underestimation of cost and length of the project were the primary causes of project cost overruns in Zimbabwe's construction industry.

Ubani, et al. (2019) revealed that Payment certificate delays, underestimation of the cost of the project, project size and complexity, weak management at the site, lack of experience by the contractor, variation of prices of raw materials, variation in prices of manufactured materials, high machinery costs, interruptions in phases between designing and procurement, use of poor and inaccurate cost estimation tools, government policies with unsupportive frameworks, and underestimation of cost and length of the project are the factors which lead to expanding the venture cost in the South Eastern Nigeria development industry. The causation and effects of cost overruns and delays were revealed to be due to several varying causes as per studies by Patel et al. (2016). This list of reasons includes underestimation of the cost and length of the project, weak knowledge of the context of changes in exchange, risks surrounding the environment, weak experience and knowledge in terms of complex project planning, geological risks as well as poor decision-making by key stakeholders to a project (Patel, Jain, & Saraswat, 2016). Variations of material prices, inaccuracies in estimates for materials, the financial standing of the Contractor as well as weak management can be identified as the

common factors that create cost overruns and delays in the construction industry of developing countries although other factors are to be different in terms of the uniqueness of the project (Ahady, Gupta, & Malik, 2017). Therefore, all the above authors have done the same research aim but in different contexts such as the Australian construction industry, Pakistan construction industry,

Malaysian construction industry, Zimbabwe construction industry, and South-eastern Nigeria construction industry. Such studies revealed some of the contexts have the same reasons for cost overrun in the construction industry and the summary of the cost overrun issues in different contexts is summarised and shown in below Table 1.

**Table 1 – Causes of Cost Overruns in Construction Sector**

<b>Cause of Cost Overrun</b>	<b>References</b>	<b>Context</b>
Deficiencies in both planning and scheduling	(Shah,2016), (Azhar, et al., 2008), (Muhammad, et al., 2018), (Thabani, 2019), (Ubani & Okoroji, 2013), (Patel, Jain, & Saraswat, 2016), (Ahady, Gupta, & Malik, 2017)	Australia, Ghana, Malaysia, Zimbabwe, South Easter Nigeria
Construction methods	(Shah,2016), (Muhammad, et al., 2018), (Thabani, 2019), (Ubani & Okoroji, 2013), (Patel, Jain, & Saraswat, 2016), (Ahady, Gupta, & Malik, 2017)	Australia, Malaysia, Zimbabwe, South Easter Nigeria
Lack of effective monitoring and processes for feedback	(Shah,2016), (Muhammad, et al., 2018), (Thabani, 2019), (Ubani & Okoroji, 2013), (Patel, Jain, & Saraswat, 2016), (Ahady, Gupta, & Malik, 2017)	Australia, Malaysia, Zimbabwe, South Easter Nigeria
certification delays	(Shah,2016), (Muhammad, et al., 2018), (Thabani, 2019), (Ubani & Okoroji, 2013), (Patel, Jain, & Saraswat, 2016), (Ahady, Gupta, & Malik, 2017)	Australia, Malaysia, Zimbabwe, South Easter Nigeria
Underestimation of the cost of the project	(Shah,2016), (Muhammad, et al., 2018), (Thabani, 2019), (Ubani & Okoroji, 2013), (Ubani & Okoroji, 2013), (Patel, Jain, & Saraswat, 2016), (Ahady, Gupta, & Malik, 2017)	Malaysia, Zimbabwe, South Easter Nigeria
Project size and complexity	(Shah,2016), (Muhammad, et al., 2018), (Thabani, 2019), (Ubani & Okoroji, 2013), (Patel, Jain, & Saraswat, 2016), (Ahady, Gupta, & Malik, 2017)	Malaysia, Zimbabwe, South Easter Nigeria
Poor site management	(Shah,2016), (Muhammad, et al., 2018), (Thabani, 2019), (Ubani & Okoroji, 2013), (Patel, Jain, & Saraswat, 2016), (Ahady, Gupta, & Malik, 2017)	Ghana, Malaysia, Zimbabwe, South Easter Nigeria
Lack of experience by the Contractor	(Shah,2016), (Muhammad, et al., 2018), (Ubani & Okoroji, 2013), (Patel, Jain, & Saraswat, 2016)	Ghana, Malaysia, South Easter Nigeria
Variation of prices of raw materials	(Azhar, et al., 2008), (Muhammad, et al., 2018), (Ubani & Okoroji, 2013), (Patel, Jain, & Saraswat, 2016), (Ahady, Gupta, & Malik,	Ghana, Malaysia, South Easter Nigeria

	2017)	
Variation in prices of manufactured materials	(Azhar, et al., 2008), (Muhammad, et al., 2018), (Ubani & Okoroji, 2013), (Patel, Jain, & Saraswat, 2016), (Ahady, Gupta, & Malik, 2017)	Ghana, Malaysia, South Easter Nigeria
High Machinery Cost	(Azhar, et al., 2008), (Muhammad, et al., 2018), (Ubani & Okoroji, 2013), (Patel, Jain, & Saraswat, 2016), (Ahady, Gupta, & Malik, 2017)	Ghana, Malaysia, South Easter Nigeria
Interruptions in phases between designing and procurement	(Azhar, et al., 2008), (Muhammad, et al., 2018), (Ubani & Okoroji, 2013), (Patel, Jain, & Saraswat, 2016), (Ahady, Gupta, & Malik, 2017)	Ghana, Malaysia, South Easter Nigeria
Use of poor and inaccurate cost estimation tools	(Azhar, et al., 2008), (Muhammad, et al., 2018), (Ubani & Okoroji, 2013), (Ahady, Gupta, & Malik, 2017)	Ghana, Malaysia, South Easter Nigeria
Government policies with unsupportive frameworks	(Azhar, et al., 2008), (Muhammad, et al., 2018), (Ubani & Okoroji, 2013), (Ahady, Gupta, & Malik, 2017)	Ghana, Malaysia, South Easter Nigeria
Underestimation of cost and length of the project	(Muhammad, et al., 2018), (Ubani & Okoroji, 2013), (Ahady, Gupta, & Malik, 2017)	Malaysia, South Easter Nigeria

## 2.2 Methods

Background research and a literature review were conducted early in the research process to collect existing information from many types of resources, such as journal articles, conference proceedings, books and electronic sources among others. The background study offered an overview of the research problem's knowledge gap and existing knowledge level. The analysis of the literature provided a clear and deeper true picture of the research topic. Creswell (2014) revealed three research approaches: quantitative, qualitative, and hybrid techniques. After analysing the characteristics of this research, the mixed strategy was determined as a research approach for this study. Accordingly, a comprehensive literature review helped to discover the existing knowledge in relation to the research aim. Based on the findings of the literature review, an e-based closed-ended questionnaire survey was carried out to collect data in relation to causes of cost overrun in the Sri Lankan building construction sector. Accordingly, eighty (80)

construction industry professionals who had knowledge of cost overruns and sustainable developments in Sri Lanka were selected as a sample size of this study. The collected data through a questionnaire survey was analysed using the Mean Weighted Rating Formula shown below.

$$\text{Mean Weighted Rating Formula} = \frac{\sum V_i \times F_i}{n}$$

Where,

$V_i$  - Rating given by the respondent

$F_i$  - Frequency of responses

$n$  - Total number of responses

Accordingly, the analysis of the data collected through the questionnaire survey was done based on the 'Mean Weighted Rating', according to the factor's ratings given by the respondents. Each factor was assessed along with the given weights of (5) for highly possible, (4) for possible, (3) for neutral, (2) for not possible, and (1) for highly not possible. As mentioned above the



“possible factors” was given the weightage as 04. Therefore, a Mean Weighted Rate value equal to or above 1.00 was selected as a possible factor.

Following the analysis of the questionnaire survey results, a series of semi-structured expert interviews were conducted to propose suitable practical solutions to minimise cost overrun using sustainable construction materials in the Sri Lankan construction sector. The population for this research was considered to be all professionals who are involved in sustainable construction work in Sri Lanka. The target population of this study is limited to all professionals both men and women who are involved in sustainable construction works in the Colombo district. Therefore, using the convenience random sampling method, 10 numbers of samples for expert interviews were extracted. The data collected through the semi-structured expert interview was analysed using the manual content analysis technique.

### 3. Results and Discussion

#### 3.1 Professional Categories of Questionnaire Survey Respondents

Eighty (80) construction industrial experts in different professional categories such as quantity surveyors, architects, engineers, and facility managers are selected as the sample of this research, and a closed-ended questionnaire survey was carried out using google forms. Accordingly, fifty-three (53) respondents received a response rate of 66.25%. In addition to that, the participants have consisting various professional categories such as twenty-two (22) respondents are quantity surveyors, twenty (20) respondents are engineers, nine (09) respondents are architects, and two (02) respondents are facility managers shown in below Figure 1.



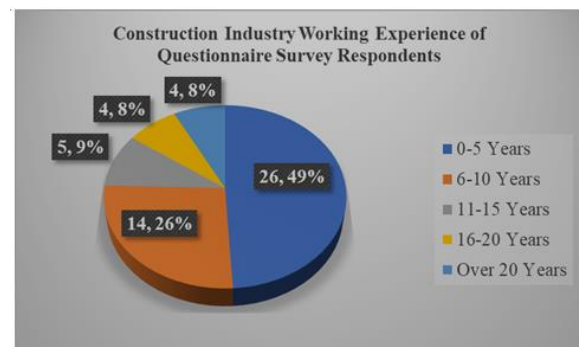
Figure 1 - Professional Categories of Questionnaire Survey Respondents

#### 3.2 Construction Industry Working Experience of Questionnaire Survey Respondents

Furthermore, Figure 2 below shows the participants' construction industry experience. According to that, twenty-six (26) participants are having 0-5 years' experience, fourteen (14) participants are having 6-10 years of experience, five (05) participants are having 11-15 years' experience, four (04) participants are having 16-20 years of experience and four (04) participants are having over 20 years of experience.

Figure 2 - Construction Industry Working Experience of Questionnaire Survey Respondents

#### 3.2 Causes of Cost Overrun in Sri Lankan



#### Construction Industry

According to the performed analysis, the results are shown in below Table 2.

**Table 2 – Mean Weighted (MW) Rate for Causes of Cost Overrun Construction Industry**

<b>Cause of Cost Overrun Factors</b>	<b>MW Rate</b>
Deficiencies in both planning and scheduling	1.321
Construction methods	1.283
Lack of effective monitoring and processes for feedback	1.302
Certification delays	1.259
Underestimation of the cost of the project	1.340
Project size and complexity	1.340
Poor site management	1.377
Lack of experience by the Contractor	1.358
Variation of prices of raw materials	1.259
Variation in prices of manufactured materials	1.226
High Machinery Cost	1.283
Interruptions in phases between designing and procurement	1.358
Use of poor and inaccurate cost estimation tools	1.358
Government policies with unsupportive frameworks	1.396
Underestimation of cost and length of the project	1.434

It is evident that all the cost overruns factors mean the weighted value is higher than 1. Therefore, all the above factors such as deficiencies in both planning and scheduling, construction methods, and lack of effective monitoring and processes for feedback are the underlying reasons and impact of identified cost overrun issues in Sri Lanka. This has been proven by the following authors such as (Ali & Kamaruzzaman, 2010), (Ahady, Gupta, & Malik, 2017), (Hiroshan&Hadiwattege, 2014), (Azhar, Farooqui, & Ahmed, 2008) through their studies and considered context. Furthermore, cost overruns in construction budgets are also caused by a lack of planning and scheduling, as well as change requests. A modification order is issued

when an owner or contractor realizes that a design isn't working or seeks to include new standards, adjustments, or demands after the initial models and budgets have been completed (Ali & Kamaruzzaman, 2010). A lack of monitoring and feedback systems causes cost overruns in construction projects. The absence of monitoring and feedback procedures revealed the contractor's ineptitude and weakness. For a project to go smoothly, a contractor must be able to control the site personnel. Several contractors failed to collaborate with their site personnel due to a lack of communication. A breakdown in communication between contractor site staff and the employer might result in a range of problems. Contractors and site employees should collaborate to solve problems (Vaardini, Karthiyayini, & Ezhilmathi, 2016). In addition to that, through the carried out analysis, it was found that payment certificate delays, underestimation of the cost of the project, project size and complexity, weak management at the site, lack of experience by the contractor, variation of prices of raw materials, variation in prices of manufactured materials, high machinery costs, interruptions in phases between designing and procurement, use of poor and inaccurate cost estimation tools, government policies with unsupportive frameworks, and underestimation of cost and length of the project can be considered as cost overrun issues in the construction industry of Sri Lanka. These factors were also confirmed by various authors such as (Abeynayake, 2010), (Ahady, Gupta, & Malik, 2017). (Ali & Kamaruzzaman, 2010), (Buckley, 2020), (Dobson, Sourani, Sertyesilisik, & Tunstall, 2013), (Hammed, Ismail, & Mohd, Factors affecting construction cost in mara large construction project, 2010), (Malkanathi, Premalal, &Mudalige, 2017), (Malkanathi, Premalal, &Mudalige, 2017) and (Vaardini,

Karthiyayini, & Ezhilmathi, 2016) through their studies. In addition to that, the literature review that most of the above-identified cost overrun factors are applicable to developed countries as well. Hence, it is evident that the above cost overrun factors are not dependent on the level of a country.

In addition to that, Ahad, et al. (2017) revealed that deficiencies in both planning and scheduling (MW=1.321), construction methods (MW=1.283), lack of effect on monitoring and processes for feedback (MW=1.302), underestimation of the cost of the project (MW=1.340), lack of experience by the Contractor (MW=1.358), weak management at the site (MW=1.377) are born by the contractors' side in developing countries. In addition to that, the same author concluded underestimation of the cost and length of the project (MW=1.434), payment certificate delays (MW=1.259), and project size and complexity (MW=1.340) cost overrun factors are born due to the fault of employers. Shah (2016) found that the use of poor and inaccurate cost estimation tools (MW=1.358) and interruptions in phases between designing and procurement (MW=1.358) causes caused by both employers and contractors. Furthermore, variations in prices of raw materials (MW=1.259), variations in prices of manufactured materials (MW=1.226), high machinery costs (MW=1.283), and government policies with unsupportive frameworks (MW=1.396) causations occurred due to third-party reasons in Malaysia, Ghana and Australia (Shah, 2016). In addition to that Ali & Kamaruzzaman (2010) revealed due to a lack of effective monitoring and process for feedback, were led to raising more deficiencies in both planning and scheduling, price fluctuations of resources, and underestimation of cost and project duration. Previous studies conducted in Uganda and Asian countries such as South

Korea, Hong Kong, Taiwan, Sri Lanka, Vietnam, Malaysia, Singapore and other countries showed due to the lack of experience by the contractor was initiate various causations such as Deficiencies in both planning and scheduling, construction methods, lack of effect on monitoring and processes for feedback, payment certificate delays, underestimation of the cost of the project, project size and complexity, weak management at site, interruptions in phases between designing and procurement, use of poor and inaccurate cost estimation tools and underestimation of cost and length of the project which is lead to raise project cost (Park & Papadopoulou, 2012, Apolot, et al., 2013).

Based on the findings of the questionnaire survey, minimisation strategies for the above-identified cost overrun factors using sustainable construction materials in the Sri Lankan Construction Industry. The data gathered through the interview was analysed and discussed below.

### **3.3 Demographic Information of the Interviewers**

As discussed in the Methods section, the interview guideline first section was focused to gather information regarding the demographic data of interviewers. Accordingly, ten (10) construction industry professionals who are having knowledge regarding cost overrun and sustainable construction in Sri Lanka were interviewed and their demographic information is shown in below Table 3.

**Table 3 – Demographic Data of Interviewers**

Code	Profession	Working Experience
R1	Civil Engineer	20 Years
R2	Civil Engineer	07 Years
R3	Civil Engineer	14 Years
R4	Quantity Surveyor	06 Years
R5	Civil Engineer	12 Years
R6	Civil Engineer	15 Years
R7	Quantity Surveyor	10 Years
R8	Architect	07 Years
R9	Quantity Surveyor	15 Years
R10	Architect	10 Years

As shown in above Table 3, the sample of the semi-structured expert interview was consisting of various professionals such as civil engineers, quantity surveyors and Architects. Accordingly, five civil engineers, three numbers of quantity surveyors and two numbers of architects contributed their knowledge to this study. When considering the Sri Lankan construction industry working experience of the above interviewers, seven professionals have more than 10 years of working experience, and three professionals have below 10 years of working experience.

### **3.4 Minimisation Strategies for above Identified Cost Overrun Factors Using Sustainable Construction Material in Sri Lankan Construction Industry**

All interviewers agreed that during the design stage relevant professionals need to examine and find out alternative sustainable materials rather than natural materials. Then evaluate the features of sustainable material in terms of time, cost and quality parameters and report to the client regarding pros and cons of applying such sustainable material to the project. R1, R2, R5 and R10 added price variation can be controlled by using

sustainable materials, for example, sea sand or M sand instead of river sand, sustainable concrete instead of concrete and sustainable bricks instead of bricks. However, R7 mentioned that sometimes there's a monopoly for some manufactured materials and they will increase the price as per their requirements. Hence, using sustainable material which has a monopoly market will lead to an increase in the project cost. Furthermore, R7 and R10 said when a contractor does not use sustainable materials before and always thinks to apply the oldest ways for construction methods and that can be caused to overrun the project cost. R4 and R8 added that project costs can be reduced when incorporating sustainable materials at the design stage. Even at the construction stage contractor can provide sustainable materials as alternatives so that the cost overrun can be reduced. Furthermore, R3 mentioned that freight rate increase in the global shipping industry and all material prices increases in the global market. But the market situation has gotten more and more volatile with the allowed flexibility of exchange rate from the start of March 2022 by the Central Bank of Sri Lanka due to the foreign currency shortage in the country. Therefore, cost overrun issues cannot ignore prevent at all in the construction industry. It is suggested considering the sustainable construction material to avoid this issue. *R5 revealed that* scam and robbery of resources especially money and the materials may result in cost overrun issues in the industry at a considerable rate of loss. Regular auditing of resources both internally and externally employed auditors and widening the site

security. Spending considerable money on the infrastructure development of the contractor's people may just add a huge cost to the project compared to the profit. To overcome this issue, movable labour huts can be used, and temporary showers can be introduced for hygienic purposes. R6 stated the cost overrun has severely hit the status of the Sri Lankan construction industry. It is highlighted that the identification of modern, advanced, practical construction methods is needed to implement in the industry using sustainable materials.

#### 4. Conclusion

The construction industry plays an important role in the development of the country. The success of a project depends on how it can meet its cost, quality, and time goals. To be successful in a project, it is important to plan the project well and have an appropriate monitoring mechanism in place. Furthermore, the construction industry causes various environmental effects. Hence, this study recommended the following strategies to minimise cost overrun in the Sri Lankan construction industry using sustainable construction materials, as mentioned below.

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- During the design stage, relevant professionals need to examine and find out alternative sustainable materials rather than natural materials. Then evaluate the features of sustainable material in terms of time, cost and quality parameters and report to the client regarding the pros and cons of applying such sustainable material to the project.
- Fixed the price of monopoly sustainable material or order the material in the early stage.
- Using sustainable construction materials can lead to the use of new technologies. Hence, it will lead to the practice of new construction methods rather than traditional methods.
- Arrange some financial framework for importing sustainable material and introduce new friendly government rules and regulations for sustainable construction.

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