Material Wastage on Cost Overrun in Construction Projects: An Impact Study Carried Out in Sri Lanka

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ABSTRACT

Cost overruns are a prevalent issue in construction industry, and material wastage is recognized as one of the key contributory factors of it. Against that background, this research investigates the impact of material wastage on cost overruns in construction projects experienced in Sri Lanka. It strives to achieve the objective of providing insights into the relationship between material wastage and cost overruns and identifying potential strategies to mitigate its impact. The research methodology developed in this concern involves a comprehensive literature review to establish a theoretical premise of material wastage and cost overruns in construction projects. The data about the issue was collected through surveys, interviews, and site inspections of a series of ongoing and completed construction projects in Sri Lanka. Later, the data was analyzed statistically to determine the extent of material wastage and its impact on cost overruns. The findings achieved thereby reveal a significant correlation between material wastage and cost overruns in construction projects in Sri Lanka, highlighting that inefficient project planning, inadequate supervision, lack of skilled labour, and ineffective procurement practices contribute to material wastage, which ultimately leads to cost overruns. The financial implications of this situation are substantial and affect project budgets and profitability. Based on the research findings, the paper strives to make recommendations for strategies to mitigate material wastage and reduce cost overruns in construction projects. These include improved project planning and scheduling, enhanced supervision and training, effective procurement and inventory management, and adoption of sustainable construction practices.

KEYWORDS: *Material Wastage, Cost Overrun, Causes, Mitigation Mechanisms.*

7 INTRODUCTION

A significant portion of material waste occurs practically in all forms of construction projects carried out in developing countries like Sri Lanka. It is discovered that 60% of the raw materials used in construction are allocated to civil works and building projects. Around 40% of the waste produced worldwide comes from building construction and demolition (Solís-Guzmán et al., 2009). For instance, the waste rate of concrete and motor in Sri Lanka is as high as 21% and 25% respectively due to improper management (P. Coomasaru, 2018). Further, road construction projects are regarded as high-risk projects due to their likelihood of cost overruns, which primarily result from material wastage (Ogbu & Adindu, 2019).

This research examined the causes of waste generation in construction projects in Sri Lanka, how material waste contributes to cost overruns, and how to control costs by minimizing waste. Each project's ability to meet its targets in terms of cost, quality, and time determines its success. Material waste can lead to cost overruns for contractors. This is because material waste can lead to delays, additional purchases, and disposal costs. Contractors can reduce cost overruns by carefully planning and budgeting for materials, efficiently managing materials on site, and using recycled and salvaged materials (Jayathilaka, 2021). A previous study found that 30% of the supplies that were bought ended up being wasted, which resulted in a total cost overrun (Eze, 2017).

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In order to make construction projects more advantageous for all interested parties, it is essential to investigate how much waste is now produced and the factors that contribute to this waste creation. Therefore, it is recommended that at various stages of the construction process, a strategy should be created to reduce waste.

8 LITERATURE REVIEW

In the construction sector, material wastage is a major issue and its impact on cost overruns must be extensively studied. Several studies have highlighted material wastage in the construction industry. Material wastage is defined as the difference between the actual amount of materials used in a construction project and the estimated amount of materials required. John and Itodo (2013) conducted a study that determined the most wasted materials during construction operations. Further, construction projects are the biggest consumers of resources even though up to 35% of solid waste generated worldwide comes from these construction activities (Llatas, 2011). The construction industry is facing a serious problem with construction and demolition waste (CDW). The building and construction industries use about 40% of the materials produced. Every year, the worldwide construction industry utilizes 25% virgin timber and 40% unprocessed stone, gravel, and sand (Kulatunga et al., 2006). A previous study calculated that the project design is responsible for 33% or so of the waste generated on-site. Thus, it is not suitable for the construction company to be solely responsible for waste reduction (Arslan et al., 2012)

Construction material waste, encompassing leftovers from supplies used on-site, arises from various building materials. A study by Vivian and Tama (2005) identifies concrete, reinforcement, formwork, brick and block, and tile as major categories. Kazaz et al. (2015) note that the concrete budget in construction projects typically constitutes 10%, contributing significantly to global construction waste. Forsythe and Mate (2007) study reveals brick waste as a predominant component in Australian construction site trash by weight. Construction activities globally consume a quarter of the world's lumber and 3 billion tons of raw materials annually, leading to substantial waste during development and demolition (UNEP, 2007).

Material waste in Sri Lankan building projects stems from factors such as inefficient project management, poor planning, communication, supervision, design, lack of skilled employees, and ineffective material handling (Kumara, 2011). Issues like overordering due to bad project management and improper material handling contribute to waste. Kulatunga et al. (2004) article notes significant concrete waste in Sri Lankan construction sector, mainly attributed to poor craftsmanship, dimensional coordination, & design changes (Kulatunga et al., 2006). Sri Lanka wastes various materials, with percentages as follows: sand (25%), lime (20%), cement (14%), bricks (14%), ceramic tiles (10%), lumber (10%), rubble (7%), steel (7%), cement blocks (7%), paint (5%), asbestos sheets (3%).

2.1 Causes of Material Wastage in Construction Projects

Almost all kinds of construction projects exhibit some level of material wastage. Material waste in construction projects around the world is caused by a number of sources. Najafpoor et al. (2014) identified the processes involved in waste production throughout design, transit, and storage. According to a study by Seyis et al. (2013), the eight most common types of waste identified in the construction sector are defects/rework, waiting time, overproduction/overstaffing, over-processing, unnecessary transportation, unnecessary movement, excess inventory, and unutilized innovation. There are two types of causes of construction material waste: non-site-based and site-based. Most of the non-site-based waste is caused by overordering of materials (Jayamathan & Rameezdeen, 2014). During every stage of a building's life, which begins with the design phase and ends with demolition, construction waste is produced (Llatas, 2011). Tiles, blocks, timber formwork, and steel reinforcement are frequently cut. The two main causes of downstream waste are employees' perceptions that waste is unavoidable and a lack of supervision (Wang et al., 2015). According to Sweis et al. (2021), the main causes of selected material waste are identified in Table 1.

Table 1. Main Causes for Material Wastage

Material	Main Causes
Sand	excessive consumption, overordering, improper storage, unfavorable weather
Aggregate	Overordering and poor storage
Stone	Rework due to errors using materials that don't meet criteria
Tiles	Taking shortcuts and being unable to place small-order quantities
Blocks	Damage caused by cutting; distribution, storage and transporting
Steel	Using longer and greater diameter bars, bending bars improperly
Cement	Plastering rework, excessive thickness brought on by variations in the size of the structural elements
Pipes	Cutting-related damage
Concrete	Supply is insufficient to meet demand, resulting in rework

2.2 Impact of Material Wastage on Construction Cost Overruns

Cost overruns are significant challenges faced by the construction industry as they hinder business development as shown by previous studies (Ilyas et al., 2020). Alhaji and Ahmed (2017) found that even small cost variations in variables like labor-related cost variables or construction material cost-related variables can have a big impact on the cost overrun or time overrun for construction projects. Road construction projects are regarded as high-risk projects due to the possibility of cost overruns, which primarily result from material wastage (Ogbu & Adindu, 2019). Cost overruns in road construction projects can be attributed to a number of things, including improper project formulation, inaccurate field investigation, wrong cost estimates, poor planning during the execution stage, an inadequate plan for supplying equipment, a lack of project management during the execution stage, insufficient working, variations in the scope of work, and changes in law and order. (Subramani, 2014).

Construction material wastage is a critical concern in the industry, leading to substantial cost overruns. Kanimozhi and P. Latha (2011) emphasize that excessive resource consumption, reflected in wasted materials, directly escalates project expenses. Physical waste and nonphysical waste are the two categories into which construction waste is typically categorized according to a study by Rahman et al. (2016). Oko Ameh (2013) details material contributions to project costs, citing concrete (4%), block work (10%), screeding and plastering waste (15%), packaging (5%), and formwork (1%). Henry and Adebayo (1997) identify material waste as a major cause of cost overruns, attributing issues like overordering, damage, theft, and spoiling. Olawale and Sun (2010) underscores material wastage as a significant factor in Nigerian building project cost overruns. According to a study by Malkanthi et. al. (2017) based on a survey of C1-C5 contractors, the reasons for the cost overrun are also revealed to be design modifications, inefficient tendering processes, rising overhead, material waste, and a lack of daily monitoring.

2.3 Strategies to Reduce the Impact of Material Wastage on Cost Overruns

Wasted materials frequently occur in construction projects, which can cause cost overruns. Project delays, budget overruns, and decreased profitability can result from cost overruns. Therefore, reducing material waste is essential in construction projects. Building information modeling (BIM) might assist in reducing material waste in construction projects, according to a study by Olawale and Sun (2010). With the help of BIM, it is possible to create an accurate and detailed model of the project, which can reduce material waste throughout the planning and building phases. Also, prefabrication and modular construction were suggested in a study by Singh and Bhardwaj (2019) to reduce material waste. The necessity for on-site construction activities is decreased by prefabrication and modular construction, lowering the probability of material wastage. Furthermore, a study by Thilakarathne and Hewage (2018) recommended the use of lean construction techniques to minimize material wastage.

3 METHODOLOGY

The need for the study is determined by conducting a comprehensive literature review on material waste and budget overruns in the construction sector. This research relies on both qualitative and quantitative information obtained through a questionnaire survey. This survey is conducted among professionals in civil engineering. The type of research method used varies depending on the specific research question, the availability of resources, and the nature of the data required. Overall research methodology is presented in Figure 1.

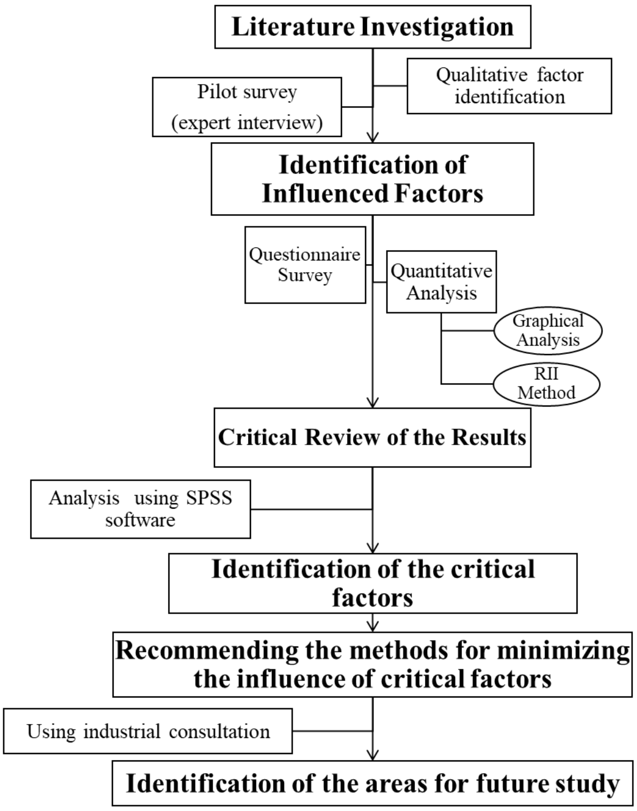

Figure 1. Methodology flow chart

Using the finalized data from the literature research, a preliminary questionnaire was developed to identify the factors that contribute to material waste and cost overruns in construction sites.

In 2023, CIDA reported a total of 452 contractors registered across CS2 to C5 categories, constituting the defined population. Parameters such as confidence interval, precision level, variability degree, and suitable response rate were chosen based on relevant literature.

By using Cochran's sample size formula

$$n_0 = \frac{Z^2 pq}{e^2} \quad (1)$$

where, p + q = 1
Z = 1.6449 (considering 90% confidence level)
p = 0.5, q = 0.5, e = 0.1

Then the sample size,

$$n_0 = \frac{1.6449^2 * 0.5 * 0.5}{0.1^2} = 68$$

$$N = 452$$

Then the adjusted sample size,

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}} \quad (2)$$

$$n = \frac{68}{1 + \frac{(68 - 1)}{452}} = 59$$

3.1 Data Collection Method

The primary data were gathered on material waste and budget overruns in projects involving construction. The questionnaire was developed using the information gathered during the preliminary survey. The data obtained from literature was used to create the preliminary questionnaire. Based on the preliminary questionnaire, the preliminary survey was carried in a flexible way helpful in improving the final questionnaire.

The questionnaires were distributed at the interviews and sent through Google Forms to professionals in construction companies who have registered within CS2 to C5 in the CIDA grading system and government organizations. While 59 responses were expected from the survey, 63 responses were received through an online platform supported by a Google Form.

3.2 Data Analysis

The data were analyzed using appropriate statistical methods and qualitative analysis techniques. A graphical analysis was created based on the responses received for each question. The majority of the results included the relevant number of replies received given as a percentage of all responses. The highest percentage response to each question was considered to be the most accurate response. Utilizing the replies gathered, data analysis using Excel and SPSS statistical software was started.

Using SPSS is recommended here for the two tasks: the identification of the relationships between the factors inside a category and classification of the relationships between the factors among the categories. Through these tasks, first, second and third objectives could be achieved. Finally using the literature review and analyzed data, the last objective (fourth) could be achieved. To assess the significance of the relevant elements in the quantitative analysis of the data, the relative importance index (RII) approach is used. The relative index is computed using a five-point Likert scale. (The 5-point Likert scale consists of the below points; Strongly Disagree- 1 point, Disagree -2 points, Neither Agree nor Disagree - 3 points, Agree - 4 points, Strongly Agree - 5 points)

$$\text{RII} = \frac{\sum \text{a n}}{\text{N}} \quad (3)$$

where,

RII	=	Relative Importance Index
a	=	Level of responses (1 to 5 range)
n	=	Number of responses for each factor
N	=	Total number of responses

4 RESULTS AND DISCUSSION

The evaluation of the "Critical Causes of Material Wastage to Overrun the Cost in Constructions" was done through a questionnaire survey sent to grade CS2 to C5 clients and contractors under CIDA registered companies, via an online platform, specifically a Google Form, 63 responses were collected.

4.1 General Overview

The responses have been categorized into six main areas of design and contract document contributed factors, project staff contributed factors, material handling and supervision contributed factors, equipment contributed factors, other external contributed factors such as Table 2 (For an easy graphic representation, the categories of design and contract document, project staff, material handling and supervision, equipment, and other external are denoted by the letters A, B, C, D, and E, respectively. The factors under those categories are represented in factor IDs Example: - A1, B1, C1…). RII values and ranking of all the contributed factors are taken using a statistical analysis. Pretesting the "reliability" and "validity" of a questionnaire is an effective way to ensure that it correctly gathers the desired information. Using SPSS, the reliability statistics and descriptive statistics of the questionnaire were examined; these are covered in the following subheadings.

Table 2. Contributed factors for material wastage

Design and contract document contributed factors (A)	**Project staff contributed factors (B)**
Design changes during construction (A1)	Lack of training and expertise (B1)
Inaccurate or incomplete design information (A2)	Rework due to labor mistakes (B2)
Time as a project priority over cost and quality (A3)	Delay in progress payments (B3)
Unclear or conflicting contract specifications (A4)	Inadequate supervision (B4)
Selecting the contractor based on the lowest price (A5)	Poor communication and coordination (B5)
The complexity of the drawings (A6)	Lack of inventory management (B6)
Preparing BOQ without considering wastage (A7)	Insufficient waste management practices (B7)
Poor material selection or specifications (A8)	Conflicts between contractors and other parties (B8)
Insufficient consideration of construction methods (A9)	Hasty or emergency work (B9)
Material handling & supervision contributed factors (C)	**Equipment contributed factors (D)**
Inefficient transportation methods (C1)	Inadequate equipment selection (D1)
Improper storage of materials (C2)	Shortage of equipment (D2)
Improper handling techniques (C3)	Equipment breakdowns or malfunctions (D3)
Changes of material types during constructing (C4)	Insufficient maintenance and repairs (D4)
Damages of select material when needed urgently (C5)	Inefficient equipment utilization (D5)
Failure to prioritize material quality control (C6)	Low level of skills of equipment operators (D6)
Late procurement of materials (C7)	Inaccurate measurement or calibration (D7)
Procuring unwanted material stocks (C8)	Lack of special and high-performance equipment (D8)
Delays of material orders (C9)	Misuse of equipment for different tasks (D9)
Delays of manufacturing construction materials (C10)	
Other External contributed factors (E)	
Effects of weather conditions (E1)	Economic fluctuations (E6)
Changes of geological factors (E2)	Issues with traffic control close to the location (E7)
Supply chain disruptions (E3)	Delay in inspections and certifications (E8)
Delay in service from utilities (E4)	Theft or vandalism (E9)
Changing government rules and regulations (E5)	

4.2 Reliability Statistics

Reliability statistics are used in research to assess the consistency and stability of a data collection. Cronbach's Alpha is a commonly used measure of internal consistency reliability for scales or questionnaires. Based on the Cronbach's alpha coefficient, this study is used to forecast the correlation between scales created with all existing scales. A typical threshold for acceptable reliability is around 0.7.

When considering both section B (causes of material wastage) and section C (Solutions to minimize material waste) of the questionnaire, Cronbach's alpha coefficient was 0.967 (Table 3). The minimal Cronbach Alpha coefficient required, which is a minimum of 0.7, based on the results of the reliability analysis for all components, the collected responses have high internal consistency and SPPS software could be used for the analysis.

Table 3. Overall reliability statistics

Cronbach's Alpha	N of Items
.967	56

4.3 Descriptive Statistics

Descriptive statistics are employed to present quantitative information in a concise and understandable format. The descriptive statistics for the questionnaire can be demonstrated in relation to the general information that was gathered from the responses such as designation of the respondents, experience in the construction industry and grade of construction company based on CIDA grading.

Table 4. Designation of the respondent

Respondents	Frequency	Percent	Valid Percent	Cumulative Percent
Architect	3	4.8	4.8	4.8
Construction Manager	2	3.2	3.2	7.9
Engineer (Resident/Planning/Design)	42	66.7	66.7	74.6
Project Manager	11	17.5	17.5	92.1
Quantity Surveyor	5	7.9	7.9	100.0
Total	**63**	**100.0**	**100.0**	

According to Table 4, most of the respondents were Engineers. (42 responses from 63.) Also, it represents 11 Project managers as well. Also, the working experience of most of the respondents is more than 15 years from 63 responses & more than 66% respondents have an experience of more than 5 years according to Figure 2. According to collected data, most of the respondents have represented government organizations (40 out of 63 responses).

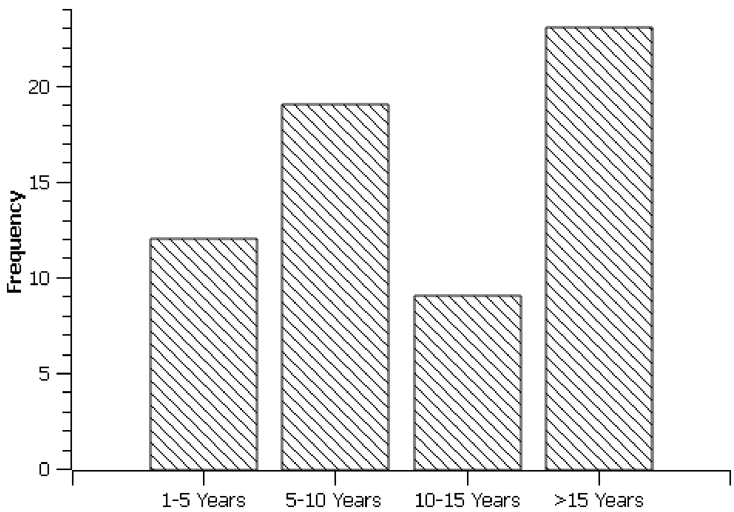

Figure 2. Experience of the respondents

4.4 RII values analysis of contributed factors

The RII values were calculated for each factor of the categories and the most critical factors were identified in Table 5.

Table 5. RII values of critical factors of the categories

Critical Factors of categories	**RII values**
Inaccurate or incomplete design information (A2)	3.95
Lack of training and expertise (B1)	4.10
Improper storage of materials (C2)	4.02
Inefficient equipment utilization (D5)	3.87
Effects of weather conditions (E1)	3.82

Then the average RII values for each category was determined based on the RII values for each factor. These are displayed in Table 6 along with the average Relative Importance Index values for each category.

Table 6. Average RII values for each category

Categories	**Category ID**	**Average RII values**
Design & contract document contributed	A	3.56
Project staff contributed	B	3.82
Material handling and supervision contributed	C	3.33
Equipment contributed	D	3.74
Other External contributed	E	3.52

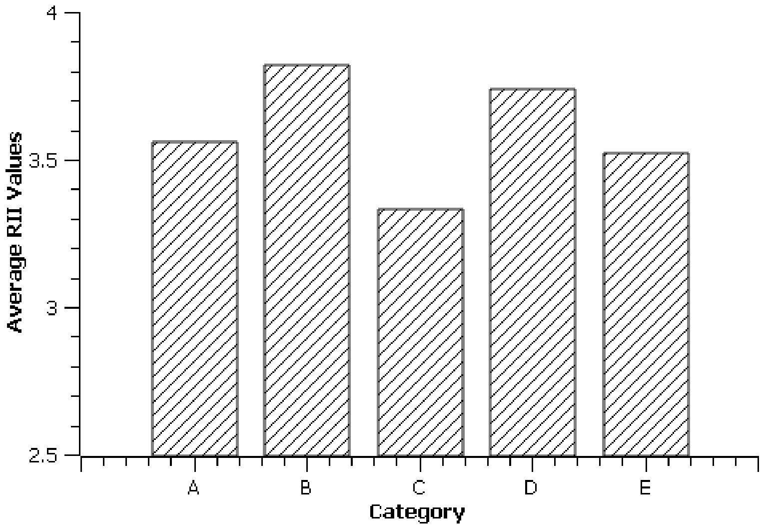

Figure 3. Average RII values for influenced categories

The factors that contribute the most to material waste and cost overruns in construction projects can be identified as project staff contributed factors, based on the average RII values for each category according to Figure 3.

Table 7. Percentage of RII for suggested solution

Suggested Solution	Percentage RII (%)
S1 - Use of precise estimation techniques	79.68
S2 - Implement efficient inventory management systems to track and control material usage	81.27
S3 - Provide training to construction workers to enhance their skills and efficiency	85.71
S4 - Consolidate material orders to take benefit of bulk discounts & reduce transportation costs.	78.10
S5 - Negotiating with suppliers to obtain competitive prices and discounts, reducing the overall cost of materials.	74.92
S6- : Apply value engineering principles to identify cost-effective alternatives for materials	81.90
S7- Properly maintain construction equipment to prevent breakdowns and delays	80.00
S8- Maintain accurate records of material usage, costs, and wastage	80.95
S9- Mitigate potential risks and delays through proactive planning and contingency strategies	78.10
S10- Adopt energy-efficient construction practices and technologies to reduce operational costs	77.46

The cells that are highlighted in Table 7 represent the most important suggestions from the highest percentage values. Proper and qualified workers are required and should be selected for the projects by all three parties, which includes contractor consultant and the client. Efficient inventory management systems are required for materials and value engineering techniques such as gathering data, thinking on it, evaluate ideas, developing, analyzing, and presenting the solutions, and implementing the changes. Therefore, it is possible to identify the recommendations that have had a significant impact on reducing material waste and cost overruns in the construction sector in Sri Lanka.

4.5 Correlation among factors and categories

The test statistic used to determine the statistical relationship or connection between two continuous variables is Pearson's correlation coefficient. It provides details regarding the strength, direction, and correlation of the relationship. It ranges from -1 (perfect negative correlation) to 1 (perfect positive correlation), with 0 indicating no linear correlation. If the correlation coefficient is between 0.6-0.8, there is a strong correlation between variables (Wang Chia-Nan et al., 2019).

By considering the results of the Pearson correlation analysis for five categories of the contributed factors, the relations were identified of each factor and the analysis was done by discussing the possible decisions that can be taken. (Example: **-** The results of the Pearson correlation analysis for the contributed factors of design and contract documents show that inaccurate or incomplete design information (A2) is strongly correlated with design changes made during construction (A1). Also, insufficient consideration of construction methods (A9) is strongly correlated with poor material selection or specifications (A8). For the above-mentioned correlations, the significance is at the 0.000 level. Therefore, it can be identified that the design changes during construction are major reasons for inaccurate and incomplete design information. By minimizing those types of major changes, it can be reduced the extra material wastage and the additional cost for purchasing. Likewise, poor material selections and choosing inaccurate specifications can be considered under the insufficient consideration on construction methods).

As category wise it can be generated the correlation as Table 8. According to the categories, there is a strong correlation between Category_A, Category_B and Category_C. Also, another strong correlation between Category_C, Category_D & Category_E. It means, if we can reduce the influence of one category from the first three categories, the material wastage and its affect to the cost overrun can be reduced. For example, if we can reduce the factors of category_A (Design & contract document contributed factors) it can also control the effect from category_B (Project staff contributed factors) and Category_C (Material handling & supervision contributed factors).

Table 8. Pearson correlation for categories

Correlations						
		Category_A	Category_B	Category_C	Category_D	Category_E
Category_A	Pearson Correlation	1	.734**	.683**	.399**	.513**
	Sig. (2-tailed)		.000	.000	.001	.000
	N	63	63	63	63	63
Category_B	Pearson Correlation	.734**	1	.712**	.537**	.589**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	63	63	63	63	63
Category_C	Pearson Correlation	.683**	.712**	1	.706**	.717**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	63	63	63	63	63
Category_D	Pearson Correlation	.399**	.537**	.706**	1	.671**
	Sig. (2-tailed)	.001	.000	.000		.000
	N	63	63	63	63	63
Category_E	Pearson Correlation	.513**	.589**	.717**	.671**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	63	63	63	63	63
**. Correlation is significant at the 0.01 level (2-tailed).						

4.6 Factor Analysis

The factor analysis is done using principal component analysis. The quantity and significance of factors are determined by a wide range of criteria in a mathematically complicated process. Also, the Varimax technique is used as a rotational technique which is orthogonal. This analysis suited mostly for design and contractor document contributed factors (A). For the interpretation of the data, it rotated the component matrix into three main components as Table 9.

Table 9. Rotated Component matrix for design & contract document related factors

	Component		
	1	**2**	**3**
A1	.860	.148	.106
A2	.813	.099	.249
A3	-.053	.718	.186
A4	.634	.238	.248
A5	.341	.703	-.165
A6	.437	.585	-.166
A7	.189	.801	.198
A8	.168	-.057	.894
A9	.238	.189	.812

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

By considering the rotated component matrix, A1, A2 and A4 factors are highly correlated with the first principal component. According to the correlation with the second principal component, it can be taken as a linear combination of A3, A5 and A8. For A8 and A9, which can also be found for the third principal component.

5 CONLUSION

According to the survey results, it can be established that the most influenced factors for material wastage and then for cost overrun in construction projects are as follows.

- Inaccurate or incomplete design information (A2)
- Lack of training and expertise (B1)
- Improper storage of materials (C2)
- Inefficient equipment utilization (D5)
- Effects of weather conditions (E1)

Also, using the average RII values and correlation analysis among the factors, the most influenced category was selected as project staff contributed factors.

According to these Percentage RII analysis of the responses, the following 10 suggestions are made as solutions proposed as the most applicable and essential for the problems faced in the construction field in Sri Lankan context.

- S1 - Use of precise estimation techniques
- S2 - Implement efficient inventory management systems to track and control material usage
- S6- : Apply value engineering principles to identify cost-effective alternatives for materials

Minimizing the impact of material wastage on cost overrun in construction projects in Sri Lanka requires a multifaceted and strategic approach. Some mechanisms for reducing this material waste in the construction industry can be identified by using the major contributing factors and the major suggestion from the results of the previous analysis.

- Enhancing the expertise and training of the key staff using skill development programs and continuous improvements – (Reason: - Project staff factors (B) significantly impact the project, as indicated by RII values. Among 63 responses, the suggestion to train construction workers (S3) received the highest percentage RII)
- Designing and strategic planning processes using extensive project planning and value engineering techniques. – (Reason - Strong correlations exist between project staff, material handling & supervision, and design & contract documents, identified through correlation analysis. The second-highest recommended solution, S6, indicates, employing value engineering principles for cost-effective material alternatives)
- Implementing advanced technologies with modern technologies such as Building Information Modelling (BIM) – (Reason - Strong correlations are found between equipment, external factors, and material handling & supervision. The third most recommended solution is effective inventory management (S2) for seasoned professionals. Equipment factors (D) have the second-highest average RII value, emphasizing their influence.)

To improve future research, it is considered expanding material waste factors from different references for more comprehensive investigations. Analyzing different waste types can provide an extensive perspective. A differential sector analysis can be achieved by increasing private sector respondents. While higher response numbers improve data accuracy, region-specific research is needed to determine significance.

The authors believe that by following the factors, suggestions and mechanisms highlighted in this paper, it would be possible for all parties in the construction sector to successfully complete their projects by guaranteeing their resources and projected profits.

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