



Evaluating the Environmental impacts of Construction Waste in Urban Area Projects in Sri Lanka

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Abstract: Rapid urbanization in Sri Lanka has led to more construction and a rise in construction waste, causing problems like soil contamination, drainage issues, air pollution, carbon emissions, and illegal dumping. Although the Central Environmental Authority (CEA) has set national guidelines, waste management practices are still inconsistent at urban construction sites. This study looks at the environmental impacts of construction waste in Sri Lankan urban projects and reviews how effective current waste management is. A structured questionnaire was given to 43 construction professionals. Their responses on a Likert scale were analyzed using the Relative Importance Index (RII), and open-ended answers were reviewed through thematic analysis. The main causes of waste were design changes during construction (RII=0.9023), poor material handling (RII=0.8977), and inaccurate material estimation (RII=0.8791). The most serious environmental issues were illegal dumping (RII=0.8884) and drainage disruption (RII=0.8140). The biggest barriers were lack of proper planning (RII=0.8837) and low worker awareness (RII=0.8093). The top suggestions for improvement were more recycling facilities (RII=0.8512) and using modern technologies (RII=0.8372). The study finds that better regulations, improved recycling, BIM technology, and more worker training are all needed to reduce the environmental impact of construction waste in urban Sri Lanka.

Index Terms: Construction waste, Environmental impacts, RII method, Sri Lanka, Urban construction, Waste management.

1 INTRODUCTION

Construction waste is a major cause of environmental problems in fast-growing countries. In Sri Lanka, the construction industry has grown quickly in cities like Colombo, Kandy, and Galle over the last ten years. This growth has produced more waste, such as concrete, bricks, steel scraps, timber, tiles, and packaging materials [1]. If not managed or disposed of properly, this waste can contaminate soil and water, block drainage, reduce air quality, and consume resources [2]. Even though the Central Environmental Authority (CEA) and Urban Development Authority (UDA) have set national guidelines, these are not always followed. Most construction sites still use landfills for waste (83.7% of respondents in this study), and there is little recycling or reuse [3]. Earlier studies have examined the construction industry as a whole but have not focused on the unique environmental issues of urban projects or measured the importance of each impact or barrier.

This study aims to fill this gap by looking at the environmental impacts of construction waste in urban projects in Sri Lanka. It uses the Relative Importance Index (RII) and thematic analysis of data from 43 construction professionals. The five research goals are to identify the main types and sources of construction waste; to analyze the environmental impacts; to assess the effectiveness of current

management practices; to identify barriers to effective waste management; and to suggest practical recommendations.

2 METHODOLOGY

2.1 Research Design

This study used both quantitative and qualitative methods. The main data came from an online questionnaire given to 43 construction professionals, including site engineers (37.2%), site supervisors (23.3%), project managers (16.3%), quantity surveyors (11.6%), and consultants (11.6%). Participants were selected to ensure they had direct experience with urban construction projects in Sri Lanka. Secondary data were obtained from published journal articles, CEA national guidelines, conference proceedings, and prior research on Sri Lankan construction waste management.

2.2 Data Analysis

The questionnaire used a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) and covered five main topics: waste generation factors, environmental impacts, current management practices, barriers, and ways to improve. The Relative Importance Index (RII) was used to rank the factors influencing occupational safety performance in equation (1).

$$RII = \frac{\sum W}{A \times N} \quad (1)$$

Where: W = Weight assigned to each factor by respondents
 N = Total number of respondents
 A = Highest possible weight (5)

where $\sum W$ is the sum of all weighted responses, A is the maximum scale value (5), and N is the number of respondents. RII values range from 0 to 1; items with $RII \geq 0.75$ are classified as High Importance, $0.55 \leq RII < 0.75$ as Moderate, and those below 0.55 as Low Importance. We reviewed open-ended answers by grouping similar responses into main themes and counting how often they appeared.

3 RESULTS AND DISCUSSION

3.1 Construction Waste Generation Factors

Table 1. RII results for waste generation factors (n = 43).

No.	Statement	Mean	RII	Rank
1	Limited storage space contributes to material wastage.	3.837	0.7674	5
2	Design changes increase construction waste generation.	4.512	0.9023	1
3	Poor material handling contributes to construction waste.	4.488	0.8977	2
4	Inaccurate material estimation leads to excess waste.	4.395	0.8791	3
5	Lack of site supervision increases waste generation.	4.093	0.8186	4
6	Lack of skilled labor contributes to material wastage.	3.837	0.7674	5

Table 1 shows the RII results for waste generation factors, with design changes during construction (RII = 0.9023) ranked first, confirming that post-commencement design modifications are the foremost driver of waste in urban projects. Poor material handling (RII = 0.8977) and inaccurate estimation (RII = 0.8791) ranked second and third, respectively, indicating that process and human-factor deficiencies dominate waste generation, consistent with Kulatunga et al. [4].

3.2 Environmental Impacts

Table 2. RII results for environmental impact factors.

No.	Statement	Mean	RII	Rank
1	Construction waste contributes to soil pollution.	3.558	0.7116	5
2	Improper disposal affects urban drainage systems.	4.070	0.8140	2
3	Construction waste contributes to air pollution.	3.372	0.6744	7
4	Waste transportation increases carbon emissions.	3.419	0.6837	6
5	Illegal dumping creates environmental problems.	4.442	0.8884	1
6	Construction waste affects visual appearance of cities.	3.905	0.7810	3
7	Construction waste depletes natural resources.	3.767	0.7535	4

Table 2 presents the RII results for the identified environmental impact factors associated with construction waste, highlighting the relative significance of each factor based on the respondents' perceptions. Illegal dumping (RII = 0.8884) was found to be the most serious environmental impact, followed by drainage disruption (RII = 0.8140). These results are similar to those of Bandara et al. [2] and Tafesse et al. [5]. Air pollution (RII = 0.6744) and carbon emissions from transport (RII = 0.6837) were rated as moderately important, meaning they are seen as less urgent than drainage and dumping issues in urban Sri Lanka.

3.3 Current Waste Management Practices

Table 3 shows that waste segregation not being practiced (RII = 0.7395) was the most acknowledged management gap, while non-transportation to approved sites (RII = 0.4465) and non-compliance with regulations (RII = 0.5442) received Low Importance ratings, indicating these failures are less prevalent. The results confirm that primary management deficiencies in urban Sri Lanka lie in segregation and recycling rather than regulatory non-compliance.

Table 3. RII Result - Current waste management practices

No.	Statement	Mean	RII	Rank
1	Waste segregation is not practiced at sites.	3.698	0.7395	1
2	Construction materials are not reused.	3.047	0.6093	4
3	Recyclable materials are not separated before disposal.	3.419	0.6837	2
4	Waste is not transported to approved disposal sites.	2.233	0.4465	6
5	Companies did not follow environmental regulations.	2.721	0.5442	5
6	Workers did not receive training.	3.419	0.6837	2

3.4 Barriers to Effective Waste Management

All five barriers received High Importance ratings (Table 4), showing broad consensus that construction waste management in Sri Lanka faces multidimensional obstacles. Lack of proper planning (RII = 0.8837) ranked first, followed by worker awareness (RII = 0.8093), lack of recycling facilities (RII = 0.7953), high costs (RII = 0.7814), and weak regulations (RII = 0.7721). This extends the findings of Kulatunga et al. [4] by showing that planning failures are as critical a barrier as human behavioral factors.

Table 4. RII Results - Barriers to Waste Management

No.	Statement	Mean	RII	Rank
1	Lack of recycling facilities affects waste management.	3.977	0.7953	3
2	Weak government regulations contribute to poor management.	3.860	0.7721	5
3	High costs discourage waste management implementation.	3.907	0.7814	4
4	Lack of worker awareness contributes to waste generation.	4.047	0.8093	2
5	Lack of proper planning increases construction waste.	4.419	0.8837	1

3.5 Recommended Improvement Strategies

All four improvement strategies were classified as High Importance (Table 5). Increasing recycling facilities (RII = 0.8512) ranked first, followed by adopting modern construction technologies (RII = 0.8372), worker training programs (RII = 0.8140), and strengthening government regulations (RII = 0.7814).

Table 5. RII Results – Improvement Strategies

No.	Statement	Mean	RII	Rank
1	Government regulations should be strengthened.	3.907	0.7814	4
2	Recycling facilities should be increased in urban areas.	4.258	0.8512	1
3	Training programs for workers can reduce waste.	4.070	0.8140	3
4	Modern technologies can help minimize waste generation.	4.186	0.8372	2

3.6 Thematic Analysis of Open-Ended Responses

Thematic analysis of the open-ended answers found four main themes. First, design changes and rework (40% of responses to Q39) were the main causes of waste, as changes after work starts often mean demolishing finished work and ordering extra materials. Second, limited space on urban sites and inconsistent waste separation (37.5% each for Q41) were the biggest management challenges. Third, accurate material estimation and using BIM (40% for Q42) were the most suggested ways to reduce waste. Fourth, stronger enforcement of regulations (44% for Q43) was the most requested policy change, with calls for higher fines for illegal dumping and making non-compliance public.

4 CONCLUSION

This study gives a field-based look at the environmental impacts of construction waste in urban projects in Sri Lanka, based on data from 43 construction professionals. The main causes of waste are design changes (RII = 0.9023), poor material handling (RII = 0.8977), and inaccurate estimation (RII = 0.8791). The most serious environmental problems are illegal dumping (RII = 0.8884) and drainage disruption (RII = 0.8140). Current management is insufficient, especially for separating recyclable materials (RII = 0.4465–0.6837). The biggest barriers are lack of planning (RII = 0.8837) and low worker awareness (RII = 0.8093). The study suggests several actions: (1) build more recycling facilities in cities; (2) use BIM and digital tools to cut waste at the source; (3) make regulations stricter and increase penalties for illegal dumping; (4) require worker training programs; and (5) make waste management plans a must for building permits. These results offer useful evidence to help shape sustainable construction policies and practices in developing countries.

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