

Challenges Associated with Managing Construction and Demolition Waste in Construction Projects

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Abstract

Global urbanisation and infrastructure expansion have accelerated economic growth, but they have also brought a major environmental challenge: the management of construction and demolition (C&D) waste. To ensure that South African construction projects are managed effectively and sustainably, the study aims to guide future planning decisions and policy development. The study used a quantitative approach to its investigation with the questionnaire survey as a tool for data collection. The questionnaires were designed using closed-ended multiple-choice questions. The respondents' responses were analysed using the Mean Item Score (MIS) and Kruskal Wallis. The results show that the most critical challenges influencing the management of C&D waste are transportation costs and ineffective project management, closely followed by material quality variability and cost management. Based on the assessment of these challenges, it is recommended that stakeholders use a comprehensive strategy to effectively address the challenges associated with managing C&D waste in construction projects. The research contributes to advancing civil engineering and contractor knowledge and skills by tackling this urgent environmental and social dilemma, with tangible benefits to the environment and society.

Keywords

Management, Recycling, Reuse, Waste

1. Introduction

The rapid development of infrastructure and urbanisation worldwide has propelled economic growth, yet it has also ushered in a significant environmental challenge: managing Construction and Demolition (C&D) waste. This waste, comprised of diverse materials such as concrete, wood, metals, plastics, and glass, poses a substantial threat due to its massive contribution to global waste streams (Das *et al.*, 2015). In South Africa, a country experiencing robust economic expansion and escalating urbanisation, the administration of C&D waste has garnered increased attention. However, managing C&D waste in construction projects remains a formidable challenge, necessitating a comprehensive assessment of current practices, issues, and potential solutions. As South Africa undergoes rapid urbanisation and industrialisation, the construction sector is witnessing exponential growth, offering significant employment opportunities (Everatt & Ebrahim, 2020). While this growth promises economic advancement, the accompanying surge in C&D waste production poses a grave concern. Effective waste management strategies are imperative to mitigate risks to public health and environmental degradation (Khasana, 2023). Understanding the prevailing challenges and identifying feasible solutions require meticulously examining the current state of C&D waste management in South African construction projects.

An in-depth analysis of existing waste management practices in South African construction projects is essential to discern the strengths and weaknesses of the current system. Evaluating the efficacy of waste segregation, transportation, recycling, and disposal methods employed in the construction sector will shed light on the effectiveness of existing practices. Furthermore, understanding how legal frameworks and political dynamics influence the nation's C&D waste management procedures is crucial. The construction industry's contribution to waste generation cannot be understated, with C&D waste accounting for a substantial portion of all waste produced (Simões & Marques, 2012). High waste volumes impact contractors' disposal and transportation costs, strain landfills, and pose environmental and

societal risks (Kabirifar *et al.*, 2020). Inadequate management of C&D waste in South African construction projects, particularly in urban centre like Johannesburg, underscores the urgency of addressing this issue. This study aims to assess the effectiveness of current waste management techniques and propose waste minimization strategies, crucial for economic viability and environmental sustainability.

Through this research, we aim to contribute to sustainable construction practices by reducing the industry's environmental footprint and safeguarding public health and safety. Additionally, the study seeks to inform policy development and future planning decisions, ensuring that South African construction projects are managed sustainably and efficiently. By addressing this pressing environmental and social challenge, the research advances knowledge and skills in Civil Engineering and Contractors, offering tangible benefits to society and the environment.

2. Challenges Associated with Managing Construction and Demolition

Training programmes integrating waste management into professional courses are crucial in promoting sustainable practices among construction workers and project managers. Insufficient awareness about construction and demolition waste (C&D) often leads to improper sorting and disposal, sending valuable recyclables to landfills. This lack of education highlights the need for structured educational initiatives that incorporate waste management principles into the curriculum of construction-related courses. By integrating waste management practices into professional training, individuals in the construction industry can better understand the importance of proper waste sorting and disposal, ultimately contributing to more sustainable construction practices (Ginga *et al.*, 2020; Faruqi & Siddiqui, 2020).

Construction projects often face challenges in waste disposal due to prioritising completion over proper waste management practices. This issue is exacerbated by tight deadlines, budget constraints, and a lack of awareness (Faruqi & Siddiqui, 2020). The construction industry significantly contributes to global waste generation, with construction and demolition activities among the highest waste generators (Karaz *et al.*, 2020). The construction sector faces challenges in waste management due to vague legislation, which leads to a lack of accountability and infrastructure for proper waste handling. The absence of explicit rules hampers the enforcement of responsibilities and cooperation among stakeholders, resulting in inadequate waste management practices in construction and demolition projects. Specialised laws are crucial to define responsibilities clearly and promote collaboration among stakeholders to ensure sustainable waste management practices in the construction industry (Dąbrowska *et al.*, 2021).

The challenges in construction and demolition waste management, particularly in rural areas, are exacerbated by limited recycling facilities and market demand, leading to a reliance on conventional disposal methods that harm the environment. To address these challenges effectively, integrated efforts are required, including strategic planning, funding, awareness campaigns, and industry collaboration to develop and implement effective recycling solutions (Faisal & Kumar, 2021). In rural areas, the lack of adequate infrastructure for recycling and limited market demand for recycled materials pose significant obstacles to sustainable waste management practices in the construction and demolition sector. The challenges smaller construction firms face in implementing efficient waste management practices are often attributed to the high costs associated with waste collection, recycling, and disposal. Limited financial resources hinder the ability of smaller firms to effectively manage waste generated during construction activities, leading to reliance on conventional disposal methods that can harm the environment (Kaza *et al.*, 2018). Strategies such as sustainable design, collaboration with waste services, and seeking government support are essential to alleviate financial burdens and promote sustainability in waste management practices within the construction industry.

3. Research Methodology

This paper adopted a quantitative research method to identify the challenges of managing C&D waste in construction projects. The study area was the province of Gauteng in South Africa, particularly Johannesburg. The following professionals actively involved in construction projects in South Africa's Gauteng Province were the target populations for the current study: consulting engineers, designers, quantity surveyors, construction managers, architects, civil engineers, project managers, construction project managers, and other professionals. These professionals were selected based on the fact that they are involved with construction projects in which waste management is either being practised or not. A structured questionnaire guide was used with questions about the challenges in building waste management. Thobakgale (2016) asserted that questionnaires are well-structured, with a primary emphasis on proper sample selection to enable results to be relevant to a range of scenarios and circumstances. Thus, Google Forms, a virtual survey collection tool, was used to retrieve data from respondents. To guarantee precision and insightful replies, the questionnaire's design was thoroughly thought out, allowing respondents to express themselves while preserving

consistency. Using the Statistical Package for Social Science (SPSS) software package, the data was analysed and interpreted through Kruskal Wallis, mean item scores, and standard deviations analytical tools. The use of this descriptive statistical analysis was to determine the ranking of the identified challenges and summarise the results. The Kruskal Wallis test was carried out to determine the variability in the opinion of the various groups of respondents concerning the variables. A total of one hundred and fifty questionnaires (150) were distributed, and the analysis of data and interpretation of results were obtained from seventy-four (74) usable responses, which reflects a 49.33% response rate.

4. Findings

4.1 Demographic Information of Respondents

The demographic information of the respondents is presented in this section. When it comes to the sectors in which respondents work, the private sector is the largest group with 33.78%, followed by government (29.73%), contractors (21.62%), and consultants (14.86%). The educational qualifications of the participants are diverse, with most holding bachelor's degrees (51.35%). Honours degrees come in second (25.68%), followed by post-matric certificates or diplomas (12.16%). Matric certificate (grade 12) and master's degree tie for fourth place with 5.41%. This suggests a well-educated group of participants. In terms of professional affiliation, Civil Engineers make up the largest group (81.08%), followed by Mechanical Engineers (6.76%), Construction Project Managers (5.41%), Quantity Surveyors (4.05%), and Electrical Engineers (2.70%). When it comes to years of experience, most respondents (54.05%) have 1-5 years of experience, followed by 5-10 years (20.27%), less than one year (16.22%), and 10-15 years (9.46%).

3.2 Descriptive and Non-parametric Analysis Results

This section discusses the responses given by the participants on the challenges associated with managing C&D Waste in construction projects. The findings from Table 1 indicate that Transportation Costs, Ineffective project management, and Material Quality Variability are the most significant factors affecting construction performance, closely followed by Cost Management. Challenges also arise from Contractual requirements, Client preferences, and Logistics Coordination, while Lack of stringent regulations and policies, Technology Integration, Lack of education and training among construction workers, and C&D waste is often bulky, occupying significant space on construction sites present additional hurdles. Further issues include a Lack of compliance with various waste disposal regulations, a Lack of budget allocation for waste management in the early stages of project planning, and Recycling Infrastructure. Identifying and integrating reuse opportunities for materials can be limited, Illegal dumping, and Documentation and Reporting also contribute to the challenges. The inability to obtain waste disposal licenses, Diverse C&D materials requiring different disposal approaches, and Difficulty in determining appropriate disposal methods for the diverse range of C&D waste materials pose difficulties.

Table 1. Challenges Associated with Managing C&D Waste in Construction Projects.

Challenges	Mean	Std. Deviation	Kruskal Wallis H	Asymp . Sig	Rank
Transportation Costs: Transporting C&D waste to disposal or recycling facilities can be expensive, especially for distant sites	4.00	1.081	6.197	0.185	1
Ineffective project management	3.99	1.168	2.686	0.612	2
Material Quality Variability: Recycled materials may not always meet quality standards, affecting construction performance.	3.99	1.200	6.922	0.140	2
Cost Management: Balancing waste management costs with project budgets can be challenging.	3.97	1.209	4.708	0.319	4
Contractual requirements and client preferences	3.95	1.137	9.994	0.041	5
Logistics Coordination: Coordinating waste removal with construction activities can be logistically demanding	3.95	1.142	7.332	0.119	5
Lack of stringent Regulations and Policies	3.93	1.217	6.161	0.187	7
Technology Integration: Incorporating waste management technologies and software into traditional construction practices may face resistance.	3.93	1.240	5.957	0.202	7
Lack of education and training among construction workers	3.93	1.290	9.108	0.058	9
C&D waste is often bulky, occupying significant space on construction sites	3.92	1.165	6.693	0.153	10
Lack of compliance with various waste disposal regulations	3.92	1.195	0.334	0.988	10

Lack of budget allocation for waste management in the early stages of project planning	3.92	1.265	6.217	0.184	10
Recycling Infrastructure: Limited recycling infrastructure can hinder efforts to recycle C&D waste	3.91	1.206	10.749	0.030	13
The cost of implementing effective C&D waste management practices	3.83	1.175	6.837	0.145	14
Identifying and integrating reuse opportunities for materials can be limited.	3.80	1.188	4.883	0.300	15
Illegal Dumping	3.80	1.398	4.875	0.300	15
Documentation and Reporting: Accurate record-keeping and reporting for waste disposal can be time-consuming.	3.78	1.201	5.074	0.280	17
Inability to obtain waste disposal licenses	3.78	1.264	6.615	0.158	17
Diverse C&D materials requiring different disposal approaches	3.77	1.199	7.449	0.114	19
Difficulty in determining appropriate disposal methods for the diverse range of C&D waste materials	3.74	1.248	3.589	0.465	20

The Kruskal-Wallis Test was carried out to ascertain the significant difference between the Challenges Associated with Managing Construction & Demolition Waste in Construction Projects based on their professional practice. This test shows that the hypothesis was accepted. This was because the result of the test revealed that seventeen (17) out of twenty (20) Challenges Associated with Managing Construction & Demolition Waste have asymptotic significance values of 0.05 and above in Table 1. A significant value of above 0.05, implies that at a 95% confidence level, there is no difference in the view of the respondents, while a significant value of below 0.05 implies that at a 95% confidence level, there is a difference in the views of the respondents as to their preference.

5. Discussion

Transportation costs and ineffective project management are significant factors challenging the management of construction and demolition (C&D) waste in construction projects. Contaminated C&D waste components lead to cost- and labour-intensive actions and environmentally sound processes, exacerbating the challenge of sustainable waste management (Rašković *et al.*, 2020). Mega construction projects generating substantial C&D waste face challenges in removing, transporting, and reusing excavated materials, highlighting the issue of transportation costs (Hahladakis *et al.*, 2020). The interplay between transportation costs and ineffective project management significantly hinders the effective management of C&D waste in construction projects. Addressing these challenges requires a holistic approach that considers the environmental impact, cost implications, and operational efficiencies in handling C&D waste throughout the project lifecycle. Material quality variability and cost management are significant factors challenging the management of C&D waste in construction projects. Additionally, the lack of mature regulatory environments, insufficient data, and the slow pace of recycling facilities contribute to the challenges in managing C&D waste effectively (Pacheco-Torgal, 2020). The construction sector's rapid growth, urbanisation, and consumerist lifestyle further exacerbate solid waste management challenges, including those related to C&D waste (Albuquerque *et al.*, 2021). The challenges posed by material quality variability and cost management in handling C&D waste in construction projects necessitate comprehensive strategies that address regulatory, operational, and environmental aspects to ensure sustainable waste management practices. Managing C&D waste in construction projects can be challenging due to various factors. Contractual requirements and client preferences necessitate efficient waste management practices (Wijewickrama *et al.*, 2020). The lack of stringent regulations and policies can lead to inconsistencies in waste handling (Ginga *et al.*, 2020). Integrating technology can streamline waste management processes and enhance efficiency (Silva *et al.*, 2021). Additionally, construction workers' lack of education and training may result in improper waste disposal practices (Faruqi & Siddiqui, 2020). Construction and demolition waste, often bulky and occupying significant space on construction sites, poses logistics challenges that must be addressed (Rašković *et al.*, 2020). Addressing the challenges of managing C&D waste in construction projects requires a multi-faceted approach that includes improving regulations, enhancing education and training, integrating technology, and promoting sustainable practices in waste management. The test to establish if there is no significant difference in the responses of construction professionals based on their type of practice was broadly accepted as the asymptotic value above 0.05 is seventeen of the twenty components analysed, according to the hypothesis.

6. Conclusions and Recommendations

This paper has identified various challenges in managing C&D waste in construction projects. In conclusion, managing construction and demolition (C&D) waste in construction projects presents multifaceted challenges that demand comprehensive solutions. Factors such as transportation costs, ineffective project management, material

quality variability, and inadequate regulatory frameworks contribute to the complexity of this issue. A holistic approach is necessary to address these challenges effectively, encompassing environmental considerations, cost management, operational efficiencies, regulatory improvements, technology integration, and education and training initiatives. By adopting sustainable waste management practices and implementing robust strategies throughout the project lifecycle, stakeholders can mitigate the adverse impacts of C&D waste while promoting resource efficiency and environmental stewardship in the construction industry.

Therefore, it was recommended that stakeholders employ a comprehensive approach to successfully solve the challenges related to managing construction and demolition (C&D) waste in construction projects, based on the study of these issues. This strategy should incorporate considering the environment, managing costs as efficiently as possible, boosting operational effectiveness, strengthening regulatory frameworks, utilising technology, and funding efforts for education and training. Using sustainable waste management practices and comprehensive policies across the project lifecycle, stakeholders can simultaneously promote resource efficiency and environmental stewardship within the construction sector while mitigating the harmful impacts of building and demolition waste.

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