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Unraveling The Barriers to Effective Waste Management in The Ethiopian Construction Industry: A Multi-Method Qualitative Approach

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Abstract

There are various obstacles in Ethiopia's construction industry when managing construction and demolition waste. This paper aims to investigate the main barriers to managing construction and demolition waste in Ethiopia's construction industry. The diffusion of innovations theory and institutional theory served as the paper's theoretical foundations. A Delphi procedure was used after a systematic literature review as part of a multi-method qualitative strategy. Twenty-three documents were selected for additional review through a systematic literature review. A thematic analysis of the various barriers in the screened publications was conducted using ATLASti23. After that, a Delphi was held with 15 panelists with sufficient construction industry experience and knowledge. After every three rounds, Kendall's coefficient of concordance was calculated to assess the experts' agreement on the barriers. The absence of commitment and interest by project stakeholders, lack of integration among stakeholders, Inadequate waste disposal procedures, lack of government support and incentives, and insufficient planning on waste management were among the top ten major barriers explored. Addressing the highlighted barriers is vital to moving closer to a future with a more environmentally conscious construction industry.

Keywords: Construction Industry, Circular Economy, Construction and Demolition Waste, Delphi Technique, Systematic literature review

1. Introduction

Projects in the construction industry (CI) provide buildings, dams, roads, bridges, and other infrastructures that support social and economic development. The industry is expected to grow more because of several global megatrends: migration into urban areas, climate change, and a new global push for infrastructure [1]. If not properly designed and constructed, infrastructure projects could generate significant construction and demolition waste (CDW) that negatively impacts the environment [2],[3].

CI in Ethiopia has grown remarkably in the last few decades [4]. Consequently, the amount of CDW has also increased. This massive amount of waste creates environmental burdens, such as consuming resources, reducing green space, increasing land and air pollution, and toxic waste discharge [2]. Poor CDW management also harms the economy and society [5].

CDW in construction projects is a waste that arises from construction, renovation, and demolition activities, including excavation or formation, civil and building construction, site clearance, roadwork, demolition activities, and renovation [6].

Conventionally, CDW is transported and disposed of in landfills, wasting land resources and continually polluting the environment [7]. However, the "3R" principles of reduction, reuse, and recycling, the most currently recognized method for managing CDW, are replacing this strategy [5]. Reduction is considered the most successful and efficient strategy. It can reduce waste production and the expenses associated with waste disposal, recycling, and transportation. Reuse refers to using the same material in construction more than once, including reuse for the same function (for example, formwork in building construction) and new-life reuse for a new item of work (for example, cut-corner steel bar for shelves). Waste materials that cannot be reused will be recycled in new construction or disposed of in landfills [6]. Because it uses the least energy and processing, reuse is the best option after reduction. Recycling is preferred when reduction and reuse are

not feasible. Some new materials can be made by recycling previously used materials [8].

The concept of a circular economy and its strategies for CDW management have gained recognition in recent years [9]. Through resource circularity strategy narrowing, slowing, and closure, the circular economy of CDW management achieves the 3Rs without relying on the usage of nonrenewable resources and the resulting environmental degradation [10]. The circular economy considers an integrated supply chain in which the by-products of one industry can become resources for another [11]. The circular economy aims to maintain the value of materials and products for as long as possible to eliminate the demand for raw materials and energy, thus reducing the environmental impacts of resource extraction, emissions, and waste management [7].

The effectiveness of CDW management in some developing countries, including Ethiopia, could be much higher [12]. Identifying significant obstacles to implementing CDW management in the booming Ethiopian CI is essential as it enables major decision-makers and stakeholders to understand the barriers and serves as a basis for exploring strategies to promote waste management performance in construction projects.

Given the dearth of research on CDW management and its barriers in the Ethiopian context, this paper focused on identifying the major barriers hindering effective CDW management at construction projects in Ethiopia.

2. Theoretical Foundation

The paper was underpinned by institutional and diffusion of innovations theories. Understanding how the external institutional environment develops and affects organizations is the cornerstone of institutional theory [13]. Institutional theory justifies the reason for exploring how regulatory frameworks, cultural norms, and organizational practices influence waste management behavior within the construction industry. The theory also provides insights into how compliance, enforcement, and informal practices shape waste management practices at construction projects.

Another lens through which to view the adoption and development of novel waste management techniques across construction firms and projects is the diffusion of innovations theory[14]. A deeper comprehension of dynamics propelling the adoption of innovative waste management strategies can be attained by examining factors including awareness, resource availability, and compatibility with current practices. With the integration of the two theories, waste management in construction projects can be more thoroughly examined, leading to the development of focused interventions and policy suggestions that will enhance waste management practices in the Ethiopian CI.

3. Research Methodology

This work is an exploratory qualitative study using multiple methods. To accomplish the research objective, a systematic literature review (SLR) followed by a Delphi technique was adopted. A systematic literature review thoroughly explores pertinent papers on this paper's topic [15]. In contrast to traditional reviews, SLR employs a transparent, scientific, and replicable procedure that involves a thorough assessment of the literature based on the analysis of previous studies [16].

The researchers used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 to perform the SLR [17]. The data were acquired from Scopus and Web of Science databases. The query strings used for the search were: ("barriers" or "challenges") and ("waste management") and ("Construction").

Regarding the exclusion criteria, the authors discarded duplicate articles and articles written in languages other than English. Book chapters and book reviews were also excluded. The filtering involved screening relevant articles based on the following inclusion criteria: Studies of CDW conducted in the context of developing countries between 2014 and 2023 were included.

The research included studies in the fields of environmental science, engineering, energy, economics, econometrics, finance, social science, business management and accounting, material science, multidisciplinary, and material science. As shown in Fig. 1, the PRISMA2020 procedure was followed for article selection.

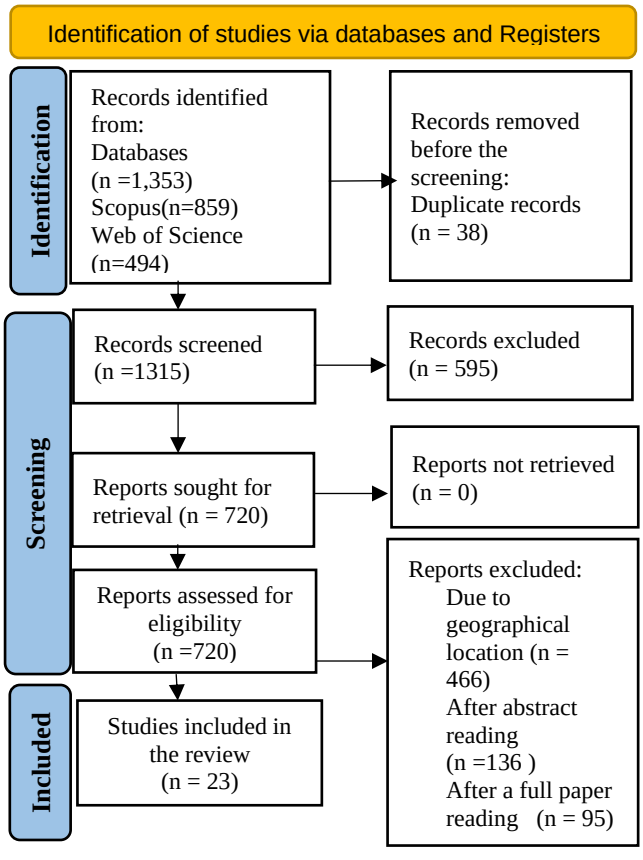

Figure 1. PRISMA 2020 flow diagram for identification of studies for synthesis

In the second phase, the Delphi technique was used to rank the obstacles to efficient waste management in Ethiopian

construction projects. The Delphi technique is mostly employed in research to gather viewpoints on a given topic or research issue to reach a consensus [18]. Fifteen panelists from various Ethiopian CI stakeholders participated in the study to guarantee diversity in the backgrounds of the expert respondents.

4. Results

4.1. Systematic Literature Review

Using the inclusion/exclusion criteria in the SLR described in the preceding sections, 23 articles were selected for data extraction following screening (Fig 1). Through a thematic analysis of the 23 publications, 26 barriers to efficient waste management in construction industries of developing countries were found.

A thematic analysis was conducted using ATLASti23, a qualitative data analysis software that facilitates the organization and coding of the data. Accordingly, different themes were explored from the 23 articles already identified using SLR.

The code occurrence table generated from ATLASti23 provided a structured overview of the barriers, allowing for a comprehensive synthesis of the findings. The barriers studied from the code occurrence table with their corresponding references are illustrated in Table 1.

Table 1. Explored barriers to effective CDW in the developing context

	Barriers	Authors /References/
1	Insufficient CDW disposal protocol	[19]
2	Lack of a robust regulatory structure	[2],[3],[11],[12],[19]-[31]
3	Financial limitations	[2],[11],[19],[21],[24],[26]-[29],[31]
4	The fragmented nature of the CI	[22],[24],[29],[30]
5	Gaps in public policy on waste management	[2],[3],[7],[12],[19]-[23],[26]-[28],[30]-[33]
6	Higher initial investment for recycling	[7],[20],[22]-[25],[27],[29],[32],[33]
7	Inadequate facilities/Infrastructures/ for waste disposal	[2],[3],[7],[11],[12],[19]-[30],[32]-[35]
8	Insufficient penalties and penalties for non-compliance	[28]
9	Insufficient area for recycling on construction project sites	[29]
10	Absence of necessary industry codes and standards	[3],[7],[20],[22],[23],[25],[29],[30],[34],[36]
11	Insufficient planning for CDW management	[2],[3],[11],[22],[28]-[34]
12	Lack of awareness and knowledge of CDW management	[2],[11],[12],[19],[26],[28]-[30]
13	Insufficient variety in the market for recycled construction materials	[22]
14	Insufficient government support and incentive	[2],[3],[11],[12],[19],[21]-[27],[30]-[34]
15	Lack of integration among stakeholders	[2],[22],[23],[26],[34]
16	Absence of commitment and interest by project stakeholders	[2],[21],[29],[33]
17	Lack of technology adoption for waste management	[20],[25],[29]-[34]
18	Gap in Legislation	[23]
19	Logistical Gaps/Shortage of reverse supply chain/	[3],[19],[20]-[22],[25],[27],[30],[32],[36]
20	Low demand for recycled products	[11],[20],[24],[26],[29],[31]
21	Non-monetization of environmental benefit	[25]
22	Operational failure	[19],[23],[25],[31]
23	Organizational-level challenges, including the absence of a responsible structure	[2],[11],[20],[24],[34]
24	Risk aversion	[7],[20],[27],[32]
25	Skepticism and resistance	[12],[22],[24],[25],[29],[36]
26	Socio-cultural problems	[2],[24],[29]

4.2. Delphi Approach

This study used the Delphi technique to rank the main barriers to effective waste management on construction projects in the Ethiopian CI. The Delphi technique is a systematic forecasting process using the collective opinion of panel members. The structured method of developing consensus among panel members using Delphi methodology has gained acceptance in diverse fields [37].

A purposive sampling technique was used to choose panelists. The selection criteria included a substantial understanding and experience of the Ethiopian CI. Candidates were required to have a minimum of 5 years of practical experience with construction projects in the Ethiopian CI to qualify as members of the panel.

The 15 panelists were chosen from academic, public, and private institutions (with mandatory practical experience) to guarantee this. Delphi studies typically involve at least ten individuals [18]. The experts' profile is depicted in Fig. 2.

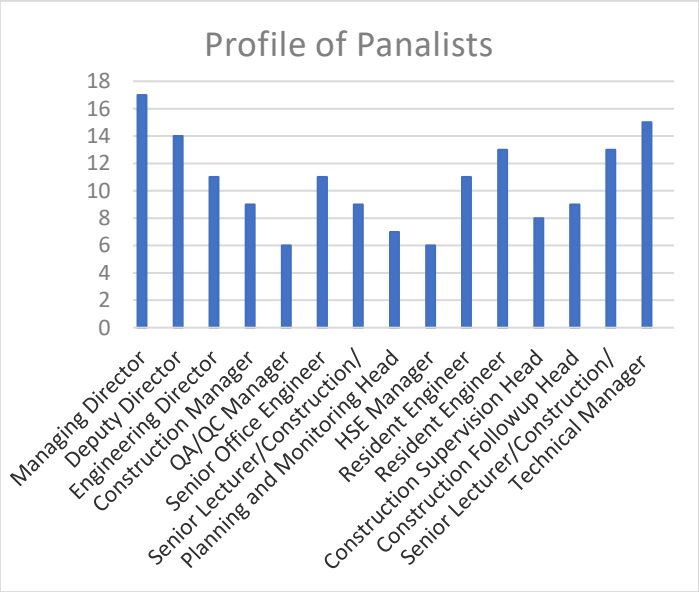

Figure 2: Panelist's profiles (current roles and years of experience)

The experts scored the 26 barriers found by the SLR in the first round, ranging from 1 (strongly disagree) to 5 (strongly agree). To allow the experts to forward additional impediments, an open-ended question was also included. A barrier that received at least a 3.0 score was chosen for additional examination [38]. It was discovered that all 26 barriers had mean scores higher than 3. The experts also forwarded three additional barriers: Negligence, lack of optimization of resources, and absence of work items for CDW activities in the Bill of Quantities of construction projects.

A calculation of Kendall's coefficient of concordance (W) using SPSS28 software was used to ascertain the degree of agreement between the experts' ratings for the barriers. The degree of consensus among experts could be gauged using Kendall's coefficient of concordance (W) [39],[40].

The panelists were then requested to score the barriers identified through an SLR in rounds to reach a better consensus. W for the first round was determined to be 0.117 (P=0.003), and three additional barriers were also forwarded by the panelists.

The experts were asked to reconsider their outlier scores from the first round and score the extra three barriers in the second round. Then W increased to 0.128.

Similarly, in the third round, W rose to 0.157 (P=0.001), indicating a further rise in consensus. For panels with more than ten members, a modest value of W is deemed significant [41]. Additionally, because the p-values were less than 0.000 when calculating W, which indicates that the results are statistically significant, the ranks of all the experts are consistent.

4.3. Ranking of the Barriers

The ranking of major barriers to effective CDW management in Ethiopia is based on the mean scores calculated from the third round of the Delphi study, as illustrated in Table 2.

Table 2. Identified critical barriers to effective waste management in the Ethiopian construction industry

Barrier	Mean	SD
Absence of commitment and interest by project stakeholders	4.6	0.63
Insufficient CDW disposal protocol	4.4	0.51
Lack of integration among stakeholders	4.33	0.62
Insufficient government support and incentive	4.33	0.62
Insufficient planning for CDW management	4.2	0.56
Financial limitations	4.2	0.68
Inadequate facilities/Infrastructures/ for waste disposal	4.2	0.68
Skepticism and resistance	4.13	0.52
Logistical Gaps/Shortage of reverse supply chain/	4.13	0.64
Insufficient variety in the market for recycled construction materials	4.13	0.83

A mean provides an average score for each barrier based on the responses of all participating experts. All the mean values were greater than 4, indicating a high agreement among the experts that the listed barriers are also significant.

A higher SD indicates greater variability in the experts' opinions, suggesting that there was less consensus or more disagreement on that barrier. Conversely, a lower SD implies that experts' responses were more clustered around the mean, reflecting higher agreement. For example, "Insufficient variety

in the market for recycled construction materials" has the highest SD (0.83), indicating more variation in responses among experts regarding this barrier. On the other hand, "Absence of commitment and interest by project stakeholders" has the lowest SD (0.63), suggesting a more consistent opinion among experts.

Next, the identified top 5 barriers to construction and demolition waste (CDW) management practice in the Ethiopian construction industry are discussed.

4.3.1. Absence of commitment and interest by project stakeholders

Successful CDW management in a construction project depends on the active participation and dedication of project owners, end users, and other stakeholders [21]. Construction firms and their project members should be responsible for implementing the strategic value of CDW management at the organizational and project levels

to realize this value.

Establishing efficient CDW management without the involvement and support of project stakeholders is challenging [29]. To further reinforce this commitment, construction firms, and other project partners must initiate workshops and training programs that emphasize the long-term economic and environmental advantages of sustainable waste management.

4.3.2. Absence of clear waste disposal procedures at a project level

It is necessary to handle the CDW carefully and dispose of it in an environmentally friendly way. The availability and application of suitable methods and procedures at construction sites impact this process, which involves waste segregation. For this, standard guidelines and channels of communication need to be in place[1]. At a project level, regular audits and feedback mechanisms should be implemented to monitor compliance and make required adjustments.

4.3.3. Lack of integration among stakeholders

Collaboration among project participants is necessary for the effective and long-term management of CDW. All parties involved, contractors, subcontractors, consultants, regulatory agencies, and others, must coordinate effectively. Generally, competing priorities and poor communication hinder effective waste management initiatives [2].

Using a shared digital platform for documenting and monitoring CDW management operations would ensure that all stakeholders are informed and in agreement with project objectives, paving the way to more efficient and well-coordinated waste management initiatives.

4.3.4. Insufficient government support and incentive

The government should provide incentives and support to promote and facilitate sustainable waste management techniques and technologies in the CI. To transition from a "linear" to a "circular" system, social actions are required; however, the government must coordinate, oversee, and facilitate these acts[3]. Government incentives should be directed towards the recovery of waste and the use of secondary materials. This entails lowering the value-added tax (VAT) on the materials substituted with secondary materials and developing policies to provide monetary and economic incentives to individuals engaged in the recycling of CDW [7].

Providing grants or subsidies to construction firms that invest in CDW recycling technologies and establishing certification programs for those that satisfy recycling targets can also accelerate the adoption of sustainable practices.

4.3.5. Insufficient planning on CDW management

Proper early planning is essential to managing waste in building projects effectively [19]. Planning must include identifying possible waste sources, setting waste reduction goals, and implementing plans for waste segregation, recycling, and disposal. Inadequate planning can result in inefficiencies and lost opportunities for waste reduction and resource recovery [27].

Many emerging economies, such as Ethiopia, lack sufficient statistics required for efficient CDW management planning [2]. Establishing a database to track and analyze CDW data would improve future planning precision and decision-making.

5. Conclusions

Sustainable national development depends significantly on efficiently managing construction and demolition waste (CDW). Different barriers in the Ethiopian CI made this difficult. The paper highlights the pressing barriers that impede CDW management in Ethiopia's burgeoning CI.

The major barriers explored in this paper include the absence of commitment and interest by project stakeholders, lack of integration among stakeholders, inadequate CDW disposal protocol, insufficient planning on CDW management, and Insufficient government support and incentives.

To promote sustainable CDW management practices—which are indispensable for resource conservation, environmental impact mitigation, and social and economic development—the main roadblocks that have been identified must be addressed proactively.

By prioritizing stakeholder engagement, establishing clear guidelines, and incentivizing sustainable practices, Ethiopia can pave the way for a more resilient and environmentally conscious CI that is aligned with global efforts towards a circular economy. Future quantitative studies are recommended in this area.

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Abbreviations

3R	Reduce, Reuse, Recycle
BOQ	Bill of Quantities
CDW	Construction and Demolition Waste
CI	Construction Industry
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
SD	Standard Deviation

SLR	Systematic Literature Review
VAT	Value-Added Tax
W	Kendall's Coefficient of Concordance

Conflict of Interest

The author states that there are no conflicting interests involved.

Author Contribution Statement

The author has conducted the research, clearly defining the problem, using appropriate data collection and analysis methods, and providing insightful interpretations.

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