Obstacles to Circular Economy Implementation for Enhanced Construction and Demolition Waste Management in Bangladesh

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Published: 31 July 2025

To cite this article: Tamnna Faruque Nawme, Mohd Reza Esa, Khalida Mohd Sukur and Mohd Arif Marhani (2025). Obstacles to circular economy implementation for enhanced construction and demolition waste management in Bangladesh. *Journal of Construction in Developing Countries*, 30(Supp. 1): 121–140. https://doi.org/10.21315/jcdc.2025.30.s1.6

To link to this article: https://doi.org/10.21315/jcdc.2025.30.s1.6

Abstract: The construction industry generates a substantial amount of waste. In Bangladesh, waste generation is projected to reach 47,000 tonnes daily by 2025. Inappropriate waste management can disrupt the natural resources in Bangladesh. The implementation of the circular economy (CE) concept could provide a viable solution to this issue. CE emphasises the efficient use of resources and waste minimisation. This study aimed to determine the significant obstacles to CE implementation in improving construction and demolition waste management in Bangladesh via a structured interview conducted with nine respondents from various backgrounds. The results revealed that the main obstacles to implementing CE were the lack of knowledge and awareness among construction practitioners, as a result of inadequate training and education programmes and imprecise existing regulations and policies. Accordingly, enforcement should be tightened to encourage more sustainable practices. The findings of this study lay a platform for construction practitioners in Bangladesh to prioritise integrating CE as an approach for construction and demolition (C&D) waste minimisation.

Keywords: Circular economy, C&D waste, Structured interview, Obstacles, Bangladesh

INTRODUCTION

Globally, the management of construction and demolition (C&D) waste has become increasingly sophisticated in recent decades. Though a huge effort to reduce the environmental footprint of C&D waste has been taken, C&D waste still risks a considerable pollution threat to the environment (Gangolells et al., 2014). According to the Ellen MacArthur Foundation (2015), the linear economy of take-make-dispose needs to be revised into a more circular approach like the circular economy (CE). A linear economy generates a huge amount of waste through the inefficient use of resources and pollutes the environment, while CE encourages the maximisation of resources through recycling elements, guided by the 3R principles of reduce, reuse and recycle (Manickam and Duraisamy, 2019).

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C&D waste is a substance or remnant result during a construction project when there is a divergence from specifications or when resources are underused or overused (Trivedi et al., 2023). The volumes of C&D waste generated are difficult to evaluate due to their variable composition, which may include materials such as concrete, bricks, soil, stones, plaster, timber, roofing stuff, plumbing appliances and electrical fixtures. On a worldwide scale, approximately 35% of C&D waste is produced, with the majority of it being disposed of in landfills without any further treatment (Menegaki and Damigos, 2018). C&D waste has become a consequential issue around the globe, whereby disposing of the waste in landfills has led to resource depletion and repetitive environmental contamination (Siddiqua, Hahladakis and Al-Attiya, 2022).

The amount of C&D waste generated in Bangladesh is higher than in some developed and developing countries. According to Islam et al. (2019), local authorities face considerable challenges in overcoming the overburden of landfills due to the predominant methods of disposing of the waste. Besides that, the C&D waste generated brings adverse effects such as air and water pollution, changes in soil formation, deficiency of resources, localised issues and transportation challenges that result in biodiversity and emergencies. Based on the *World Air Quality Report 2023*, Bangladesh produces Particulate Matter (PM) 2.5 air pollution, making it the most polluted country in the world (IQAir, 2023). Exposure to PM 2.5 air pollution leads to numerous health conditions, including asthma, cancer, stroke and lung disease (Zehnder et al., 2018). Additionally, the emissions of carbon dioxide (CO^2) are showing an upward trend in Bangladesh (Ahmed, Mahmud and Acet, 2022). In short, C&D waste is becoming a real concern in Bangladesh.

C&D waste is considered one of the biggest waste streams in the world. Approximately 30% to 40% of the total volume of solid waste comes from C&D waste (Islam et al., 2019). This significant amount of C&D waste is a result of rapid urbanisation and construction activities (Akhtar and Sarmah, 2018). According to Islam (2016), the waste that is not being collected constructively will create more issues, especially towards the environment. For example, in Dhaka, Bangladesh, only 37% of the total amount of waste is being collected, while the remaining is uncollected and not carefully disposed of (Ahsan et al., 2014; Prodhan and Kaeser, 2020). Nafiz et al. (2023) mention that the effective management of waste is challenging, especially in a densely populated nation like Bangladesh. A staggering 3,500 tonnes of mixed solid waste is generated, but only 1,800 tonnes are collected and properly disposed of in the capital city of Bangladesh (Nafiz et al., 2023). This inefficient waste management system is a significant barrier to implementing CE principles, as it fails to capture the inherent value of waste as a resource. Additionally, the lack of systematic solutions and technical options to address this issue is a critical constraint (Dong, Liu and Bian, 2021). CE provides a comprehensive approach

to explore associated ways to design a circular system that will fully utilise the materials and energy metabolism of cities (Dong, Liu and Bian, 2021). However, in Bangladesh, pressing issues on social, political and economic have made the understanding and application of integrated management systems, such as the concept of CE, remain a lower priority (Baroi et al., 2020). Also, the lack of public awareness, inadequate law enforcement, limited community sensitisation efforts and reliance on outdated technologies can all be attributed to the significant increase in C&D waste generation in Bangladesh (Chowdhury et al., 2016).

In this study, the primary aim was to investigate the obstacles that need to be overcome to implement CE as an approach to C&D waste minimisation in Bangladesh. This study provides a platform for construction practitioners in Bangladesh to understand the obstacles and helps them to better manage C&D waste. It is crucial to identify the obstacles to facilitate the implementation of CE as an approach to improve the management of C&D waste in Bangladesh.

LITERATURE REVIEW

Circular Economy

The concept of CE has emerged as a promising approach to address the growing challenges of sustainable development, particularly in the context of resource scarcity and environmental degradation (Saidani et al., 2019). According to Oliveira et al. (2021), CE is a reliable business model to replace linear production and eliminate disposal elements in the production line. Papamichael et al. (2023) believe that CE aims to keep the resources in the loop by revamping the end-of-life processes with the 3R principles. Previously, waste was viewed as a burden that needed to be disposed of in landfills. However, CE, as a novel economic paradigm, helps shift the mindset of practitioners to see waste as potentially usable resources (de Ponte, Liscio and Sospiro, 2023).

The European Commission in 2020 set CE as a foundation to increase the long-term 3R rates of C&D waste (European Environment Agency, 2020). The Republic of Croatia came up with a waste management plan that incorporates the CE concept with a focus on enhancing the sustainable management of C&D waste in the country (World Bank, 2022). Therefore, it is important to consider CE as a way forward to sustainably manage the C&D waste in Bangladesh. However, the implementation of CE principles in Bangladesh may face several obstacles that must be addressed first to realise its full potential. Consequently, the obstacles need to be identified to ensure that a smooth implementation of CE can be done in Bangladesh.

OBSTACLES IN CE IMPLEMENTATION

According to Sarja, Onkila and Mäkelä (2021), there are three categories of obstacles to CE implementation, namely: (1) catalyst factors, (2) ambivalent factors and (3) obstructive factors. Catalyst factors are the factors that could positively or negatively trigger change among construction practitioners. Ambivalent factors reflect the idea that construction practitioners are ready to change but are hindered by certain scenarios, such as a lack of demand. Meanwhile, scenarios that fully impede the change that construction practitioners are willing to take are obstructive factors.

Several authors have considered financial aspects as the main constraints to adopting CE (e.g., Lahti, Wincent and Parida, 2018; Moktadir et al., 2020a; Rizos et al., 2016; Sarja, Onkila and Mäkelä, 2021). Dulia et al. (2021) add that the risk of quality degradation of recycled materials when adopting CE also influences the decision not to implement CE. Moreover, CE is considered a threat to business-as-usual practices, as it is very challenging to implement CE, given the linear mindset prevalent among construction practitioners (Franco, 2017). Therefore, a full commitment from the top management is required to shift the mindset and introduce a new, more sustainable business model, like CE (Lahti, Wincent and Parida, 2018). However, a lack of commitment from the top management is found to be one of the obstacles in revamping an outdated system (Azizuddin, Shamsuzzoha and Piya, 2021).

Ahmed, Mahmud and Acet (2022) argue that the lack of commitment occurred due to the lack of knowledge and awareness of the benefits of adopting CE. Similarly, Adams et al. (2017) found that a low level of knowledge and awareness has made it difficult to implement CE. Besides that, CE implementation requires technological advancement to achieve the idea of transforming the linear economy. In Bangladesh, cost constraints have made it difficult to implement CE (Azizuddin, Shamsuzzoha and Piya, 2021). Previous studies showcase that a notable restriction of CE implementation is a technological shortcoming. For example, the need for enhancing the technological aspect had prevented the implementation of CE (Geisendorf and Pietrulla, 2018). Also, Ahmed, Mahmud and Acet (2022) and Kirchherr et al. (2018) agree that limited technological advancement is restricting CE adoption.

Collaborations are required to change the business-as-usual approach towards CE innovations (de Abreu and Ceglia, 2018). They need a big circle of participants with the same intention to adopt CE (Sarja, Onkila and Mäkelä, 2021). Another daunting obstacle is comprehensive regulations and policies regarding CE. According to Ahmed, Mahmud and Acet (2022), policymakers should implement regulations and policies that emphasise the importance of preserving the environment. The crucial role that the government could play in implementing CE through legislation has been highlighted in many

studies (e.g., de Abreu and Ceglia, 2018; Sarja, Onkila and Mäkelä, 2021; Scheepens, Vogtländer and Brezet, 2016). Thus, the government should deploy environmentally sound business mechanisms that prevent unsustainable activities. Table 1 summarises the obstacles to implementing CE and their codes.

Table 1. Summary of obstacles in CE implementation

Sources	Obstacles	Code
Adams et al. (2017); Sarja, Onkila and Mäkelä (2021)	Lack of knowledge and awareness	OB1
Azizuddin, Shamsuzzoha and Piya (2021); Lahti, Wincent and Parida (2018); Moktadir et al. (2020b); Rizos et al. (2016); Sarja, Onkila and Mäkelä (2021)	Financial constraints	OB2
Azizuddin, Shamsuzzoha and Piya (2021); Franco (2017); Lahti, Wincent and Parida (2018)	Managerial support	OB3
Ahmed, Mahmud and Acet (2022); Azizuddin, Shamsuzzoha and Piya (2021); Geisendorf and Pietrulla (2018); Kirchherr et al. (2018)	Technological restriction	OB4
de Abreu and Ceglia (2018); Sarja, Onkila and Mäkelä (2021)	Lack of collaboration	OB5
Ahmed, Mahmud and Acet (2022); de Abreu and Ceglia (2018); Sarja, Onkila and Mäkelä (2021); Scheepens, Vogtländer and Brezet (2016)	Comprehensive regulations and policies	OB6

METHODOLOGY

In this study, a qualitative approach was used to gain insight and understanding of the research area. The qualitative approach is a powerful tool in the realm of academic research as it offers researchers a nuanced and insightful approach to understanding complex social phenomena (Maxwell, 2008). Numerous studies have employed a qualitative approach as a research tool, such as education (e.g., Mogavi et al., 2024), healthcare (e.g., Ofosu et al., 2023) and financial management (e.g., Sharma and Choubey, 2022).

According to Antikainen, Uusitalo and Kivikytö-Reponen (2018), the qualitative approach helps researchers to explore the unique perspectives of the meanings and motivations of the targeted participants. This approach is particularly valuable when investigating topics with little prior information or when the research aims to uncover the essential elements of a phenomenon as perceived by those experiencing it. In this study, a structured interview

was employed to investigate the main obstacles to implementing CE as an approach for C&D waste management in Bangladesh.

Data Collection

The data for the current study were collected in the capital city of Bangladesh, Dhaka. The city was selected due to the rising population and development in this area (BBS [Bangladesh Bureau of Statistics], 2024). A purposive sampling strategy was used to identify the potential respondents. The sampling was to select people who could provide the information because they had conformed to all or some of the criteria set by the authors (Campbell et al., 2020). The main criterion set was that the respondents must know about the management of C&D waste.

Accordingly, a total of nine respondents from various backgrounds, including contractors, demolition companies, landfill representatives, waste management companies and government agencies, were selected to be involved in this study (as shown in Table 2). Each respondent was assigned a code to simplify the analysis process. An email and phone calls were made to arrange the schedule for the interviewing process, setting the date, time and place.

Table 2. List of respondents

Participant	Respondent	Position	Experience (Years)	Code
1	Contractor	Senior hands manager	10	P1
2	Contractor	Director	7	P2
3	Contractor	Site inspector	5	P3
4	Demolition	Technical director	4	P4
5	Demolition	Site manager	4	P5
6	Landfill	Project engineer	8	P6
7	Waste management	Recycling coordinator	6	P7
8	Waste management	Waste reduction planner	6	P8
9	Government	Joint secretary	10	P9

The structured interview was conducted to address two research questions, namely:

1. In your opinion, what are the primary obstacles to implementing CE to improve C&D waste management in Bangladesh?
2. Are we doing enough to overcome the obstacles and promote better C&D waste management in Bangladesh?

Question 1 on the obstacles identified in Table 1 was given to guide respondents so they could express opinions based on their experience. An interview session was conducted by preparing an audiotape for recording so the audiotape could be used for further validation of the data (Maxwell, 2008). At the same time, instant notes during the interview session were taken to avoid misinterpretation of the data during the analysis process.

Data Analysis

A content analysis is a reliable approach to validate the qualitative data, in this case, obtained from the interview session. A wide range of text was transcribed and then analysed using NVivo, a qualitative data analysis software. Transcribing is a preferable technique to capture the recorded speed, tone of voice, emphasis and timing of the audio (Drisko and Maschi, 2016). It was necessary to read the transcription while listening to the audio to prevent mistakes.

RESULTS AND DISCUSSION

C&D waste generation has increased significantly as a result of urbanisation. This has resulted in severe impacts on the environmental, social and economic aspects. Nevertheless, the management of C&D waste faces a multitude of obstacles, especially in a country like Bangladesh. Consequently, determining the obstacles is crucial to producing solutions for C&D waste management.

Primary Obstacles in CE Implementation

In the current study, respondents were required to select attributes associated with the obstacles they faced in the Bangladeshi construction industry. Table 3 recapitulates the response of each respondent.

Table 3. Respondent's response

Obstacles	P1	P2	P3	P4	P5	P6	P7	P8	P9
Lack of knowledge and awareness (OB1)	✓	✓	✓	✓	✓	✓	✓	✓	✓
Financial constraints (OB2)	✓		✓	✓		✓			✓
Managerial support (OB3)	✓	✓		✓		✓	✓	✓	✓
Technological restriction (OB4)	✓		✓	✓		✓			✓
Lack of collaboration (OB5)	✓	✓		✓	✓			✓	✓
Comprehensive regulations and policies (OB6)	✓	✓	✓		✓	✓	✓	✓	✓

Lack of Knowledge and Awareness

The respondents opined that knowledge and awareness of the CE concept were essential for its utilisation in construction and other industries. Figure 1 concludes the different opinions provided by the study respondents. The concept of CE encourages the integration of the 3R principle. However, P1 raised a concern regarding a lack of awareness of the potential of recycling the C&D waste and insufficient infrastructure to cater for the recycling process in Bangladesh. P3 added that construction workers were not properly trained, especially with the implementation of new ideas like sustainable construction. According to Adams et al. (2017), ineffective C&D waste management is influenced by the insufficient training programme and if there is a programme, it lacks the required techniques to properly execute the knowledge.

Preventing waste from being generated should be prioritised, as systematically elaborated in the waste management hierarchy (Sarja, Onkila and Mäkelä, 2021). Therefore, the establishment of top-down practices is required to regulate the management practice of C&D waste (Huang et al., 2018). Most of the construction practitioners are unaware of the potential benefits of adopting CE, such as maximising resources, new market opportunities and waste minimisation. To overcome this obstacle, it is essential to coordinate efforts to educate and inform the construction practitioners.

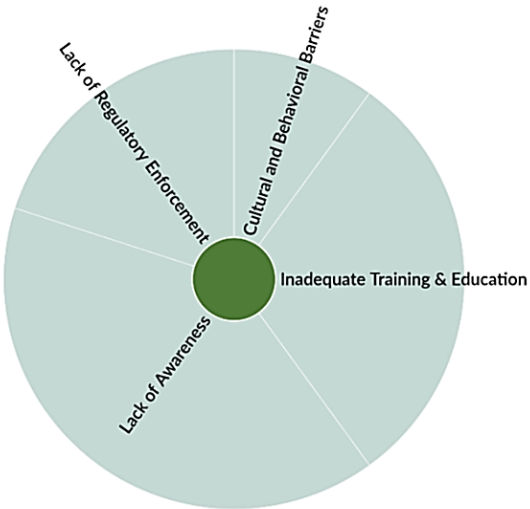

Figure 1. Summary of the lack of knowledge and awareness

Financial Constraints

Concerns were expressed by the majority of the respondents about financial constraints to implement better C&D waste management and to change the linear practices towards a more circular model, as shown in Figure 2. For instance, P2 mentioned that a cost-efficient solution might fail due to financial constraints. This finding supports the statement of Sarja, Onkila and Mäkelä (2021) and Moktadir et al. (2020b) that money is the main obstacle to CE transition. An investment in infrastructure to facilitate CE is crucial to modify the current business model for circularity (Scheepens, Vogtländer and Brezet, 2016). Meanwhile, P4 opined that a deficiency in government subsidies and incentives prevented the construction practitioners in Bangladesh from enhancing C&D waste management. According to Huang et al. (2018), subsidies and incentives help construction practitioners promote eco-friendly and energy-saving products by enhancing the recycling programme. P9 added that a lack of funding led to missed opportunities to invest in new technologies. Therefore, methods like CE could improve C&D waste management, resource recovery and recycling rates.

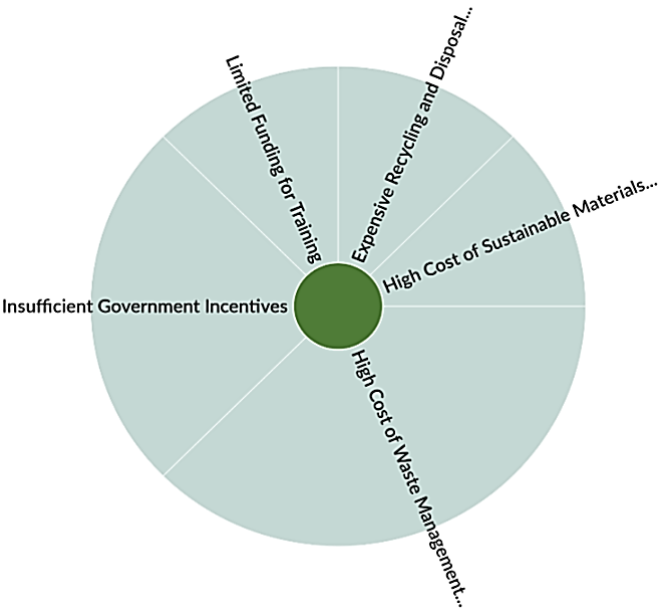

Figure 2. Summary of financial constraints

Managerial Support

Top management support is vital to successfully implementing new ideas or models. In this study, the concept of CE is used as an effective approach to manage C&D waste. Top management support could provide the necessary will, skills and resources to facilitate transformation (Lahti, Wincent and Parida, 2018). Top management support is required to encourage the changes among the individuals in the organisation so that they can pursue a transitional process smoothly (Azizuddin, Shamsuzzoha and Piya, 2021; Franco, 2017). However, according to P1, most leaders preferred project completion and cost-saving mechanisms instead of adopting more sustainable practices. Furthermore, P3 mentioned the difficulties of shifting the mindsets and behaviours of construction practitioners, particularly to diminish the linear model and start implementing a more circular approach. The feedback given by the respondents can be seen in Figure 3.

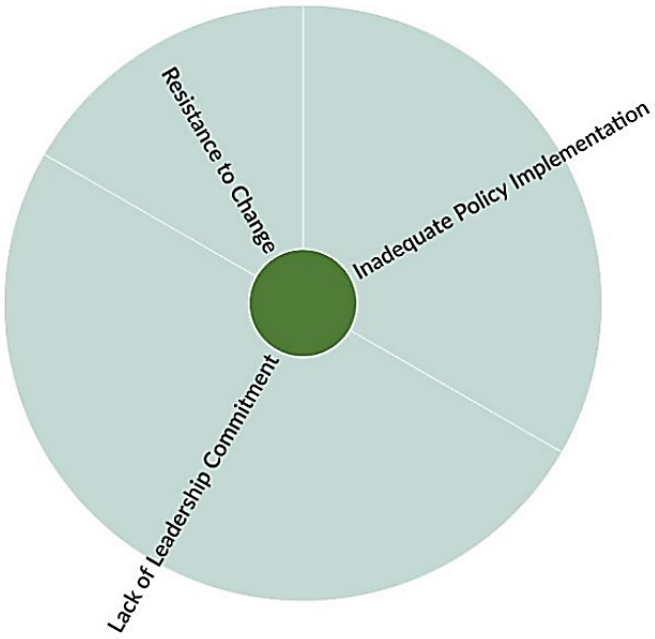

Figure 3. Summary of managerial support

Technological Restriction

According to Geisendorf and Pietrulla (2018), technology is required to implement CE throughout a supply chain, starting from design, production and usage to recycling the resources to be a new product. Current technologies might be able to execute the idea of CE implementation, but it is reasonable to have innovations and technologies developed. However, based on the result, it was demonstrated that the technological restriction might hinder the implementation of CE to manage the C&D waste (as shown in Figure 4). P4 discoursed that a slow adoption of new technologies like building information modelling (BIM) impeded the effort to promote a more sustainable practice in the Bangladeshi construction industry. This opinion was supported by P6. He mentioned that construction practitioners in Bangladesh were behind in using advanced technology like automated sorting systems and recycling facilities due to technological restrictions.

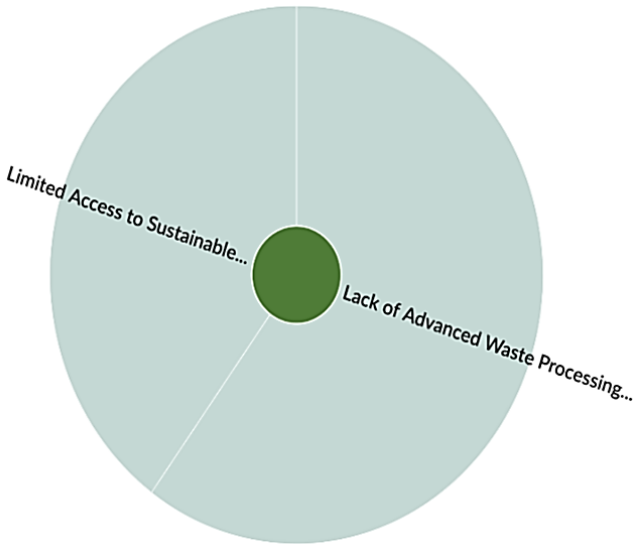

Figure 4. Summary of technological restrictions

Lack of Collaboration

CE implementation will be more effective on a larger scale. However, it requires strong collaboration and a network. In this study, six out of nine respondents agreed that a lack of collaboration made it difficult to implement CE in Bangladesh. P7 highlighted the need for a cooperative framework to ensure best practices, necessitating it for CE to be successfully adopted in managing C&D waste. The key success factor for CE implementation is collaboration (de Abreu and Ceglia, 2018). As CE practises a holistic approach that is utilised throughout the value chain, motivation to collaborate and create new partnerships to see the real impacts of CE implementation is required (Adams et al., 2017; Kirchherr et al., 2018). P1 further added that construction practitioners in the construction industry were divided due to poor communication that hindered collaboration (as shown in Figure 5). This statement corroborates with Yukalang, Clarke and Ross (2017), who suggest that communication creates awareness and enhances collaboration among construction practitioners.

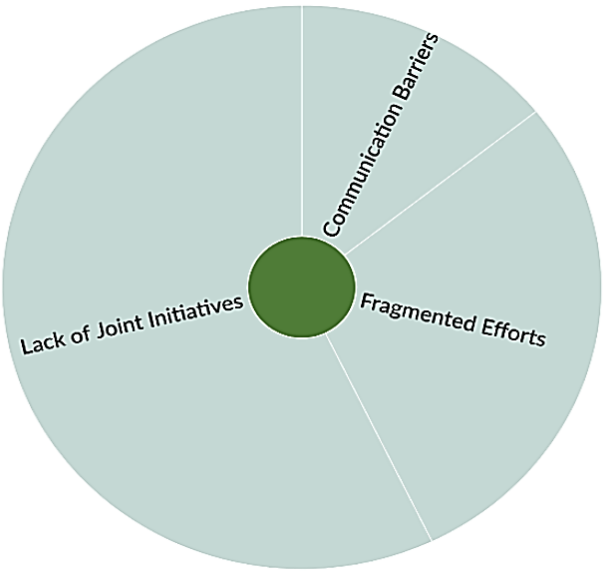

Figure 5. Summary of the lack of collaboration

Comprehensive Regulations and Policies

Except for P4, all respondents agreed that comprehensive regulations and policies were needed to ensure the implementation of CE for better C&D waste management (as shown in Figure 6). Many developed countries, such as the Netherlands, Germany, Japan and Australia, have introduced legal regulations related to the CE concept (Shooshtarian et al., 2022). When related regulations are implemented, the necessary actions towards better C&D waste management or revamping the linear model to a circular model can be enhanced. However, P6 and P8 stated that the regulations were often ignored as they were not properly monitored. This addressed the need for relevant penalties and consequences to be introduced. P5 was concerned about the overlapping mandates and unclear jurisdictions that governed C&D waste management in Bangladesh. P2 further added that several local authorities employed an ad-hoc and improper waste management plan in their area. Consistent with the previous studies, the introduction of comprehensive regulations and policies, especially from the government, would encourage CE implementation and restrict unsustainable practices in the construction industry (Sarja, Onkila and Mäkelä, 2021; Scheepens, Vogtländer and Brezet, 2016).

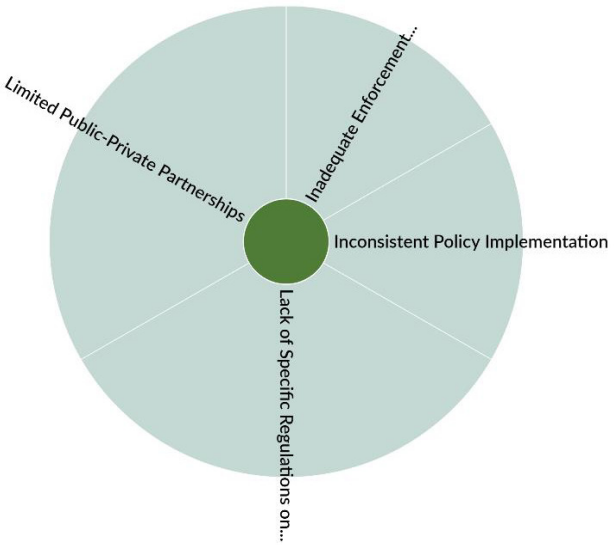

Figure 6. Summary of comprehensive regulations and policies

Overcoming the Obstacles

Concerns regarding the current practices and attitudes of construction practitioners towards C&D waste management in Bangladesh have been raised. The current study investigated perceptions towards how C&D waste management can be improved by suggesting how the stated obstacles could be solved. Different views were given by the respondents. For example, P1 stated that immediate action should be taken to tighten regulations, increase public awareness campaigns and invest in recycling facilities. P4 supported the idea by advocating for an increased number of recycling facilities and the enforcement of relevant regulations. This finding was consistent with that of Scheepens, Vogtländer and Brezet (2016), who emphasised regulation enhancement and Huang et al. (2018), who suggested the significance of enhancing the recycling programme.

Most of the respondents agreed that the government of Bangladesh attempted to create more sustainable and environmental practices by introducing related regulations. Even though the groundwork had been laid, the enforcement was still low. P8 suggested monitoring mechanisms to be enhanced and a stringent penalty to be given to non-compliant organisations. Figure 7 summarises the feedback obtained from respondents. There were positive and negative aspects to overcoming the obstacles in implementing CE. To conclude, it is necessary to address negative aspects while leveraging positive aspects to enhance C&D waste management.

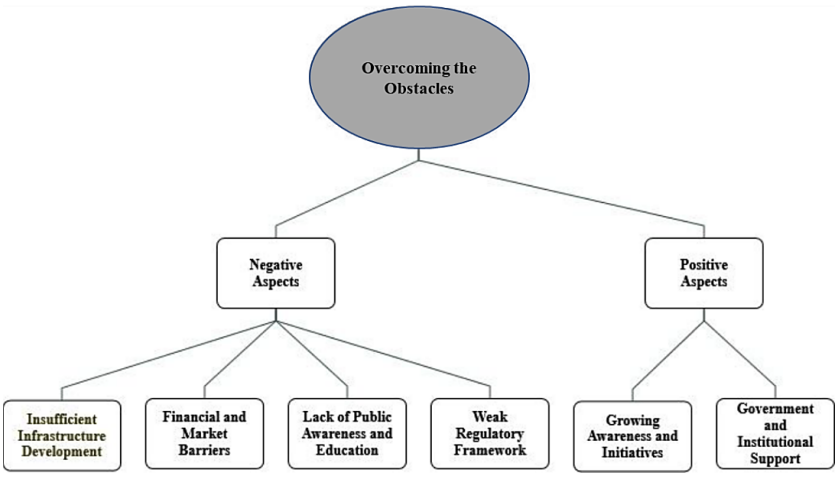

Figure 7. Different aspects of overcoming the obstacles

CONCLUSIONS

This study employed a qualitative method. The purpose of employing a structured interview was to obtain subjective opinions among the selected respondents about the scenarios of C&D waste management in Bangladesh. The current study sought to gain insight and understanding of the obstacles that could hinder effective C&D waste management using the CE concept in Bangladesh. Based on the literature, a total of six obstacles were identified. They were "Lack of knowledge and awareness" (OB1), "Financial constraints" (OB2), "Managerial support" (OB3), "Technological restriction" (OB4), "Lack of collaboration" (OB5) and "Comprehensive regulations and policies" (OB6).

The current study succeeded in making a few conclusions regarding the primary obstacles. First, there was a general lack of knowledge and awareness among construction practitioners in Bangladesh about the CE concept. Therefore, it is imperative to provide training programmes and education initiatives to foster a more sustainable culture in Bangladesh. The high initial cost of implementing CE might deter the interest of construction practitioners from investing. Subsidies and incentives should be introduced to make it more attractive. In addition, the lack of managerial support due to resistance to change within the industry contributed to the effort to implement CE in Bangladesh. This is partly due to ingrained practices and a lack of willingness to adopt new technology. Highlighting the benefits of CE could influence a shift in the mindset and attitude of the construction practitioners in Bangladesh. Rapid development also influenced the increasing amount of C&D waste. The current technology is not sufficient to handle the volume

of C&D waste. Thus, recycling facilities should be increased to facilitate effective waste management and encourage maximisation of the resources. Moreover, the current study found collaboration to be the key to ensuring the successful implementation of CE. It is quite challenging to obtain a full commitment from all organisations involved throughout the supply chain. A regulatory body like the government needs to coordinate the implementation and provide a clear platform for communication among the organisations involved. Currently, regulations and policies in Bangladesh are vague and lack enforcement mechanisms, especially related to the CE concept. There is a need for explicit and supportive policies to inspire construction practitioners to adopt more sustainable practices.

The findings of the current study are indicative of the circumstances in Bangladesh. The outcome of this study will theoretically benefit the socioeconomic conditions in Bangladesh by addressing the socioeconomic issues in waste management and shifting the focus towards a more circular model in optimising the resources in the construction industry. In addition, the selection of Bangladesh as a case study provides a platform for other low and middle-income nations to address the issues related to labour productivity, lack of regulations and resource constraints. Practically, the implementation of CE will reduce the dependency on raw materials, which will significantly help a country that has an issue with resources, like Bangladesh. The adoption of CE will also increase the number of job creation, especially in the recycling, upcycling and refurbishing industries. This study aimed to enhance understanding among interested parties and offers a foundation for policymakers to use CE strategies as a means of minimising C&D waste. Hence, a broader observation of the strategies of integrating CE as an approach for C&D waste management would be appropriate for future research.

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