Afghan International Journal of Science (AIJS)

Publisher: Afghan International Islamic University

Website: https://aijs.aiiu.edu.af/

Challenges and Strategies for Construction and Demolition Waste Management in Kabul: A Comparative Analysis and Path Forward

Imran Safi[*1], Abdulhai Kaiwaan[2], Aref Naimzad[3]

[1]*Master Student, Department of Industrial Engineering, Afghan International Islamic University (AIIU), Kabul, AF*
[2]*Assistant Professor, Department of Structural Engineering, AIIU, Kabul, Afghanistan*
[3]*Assistant Professor, Department of Industrial Engineering, AIIU, Kabul, Afghanistan*

Abstract

Rapid urbanization in cities like Kabul has created pressing challenges in managing construction and demolition (C&D) waste, including poor infrastructure, illegal dumping, inadequate segregation, and limited regulation. This paper argues that policy fragmentation and a lack of recycling infrastructure are the primary obstacles to effective construction and demolition (C&D) waste management in Kabul. By assessing Kabul's current situation, contrasting it with international practices (Australia, Kuwait, Vietnam), and highlighting context-specific research gaps, the analysis demonstrates Kabul's urgent need for targeted, enforceable policies. Employing a comparative methodology, the paper demonstrates that developed nations effectively utilize economic incentives and policy coherence to promote C&D waste management. The study concludes that Kabul can make significant improvements by adopting clear policies that incentivize recycling, enhance segregation, and embrace circular economy practices.

Keywords: Construction and Demolition Waste, C&D Waste Management, Waste Segregation, Building Information Modelling (BIM), Waste Disposal Charges, Stakeholder Engagement, Policy Development

Article History

Published: Dec 31, 2025

Accepted: Dec 26, 2025

Revised: Nov 8, 2025

Received: Oct 6, 2025

Cite as: Safi, I., Kaiwaan, A. & Naimzad, A. (2025). Challenges and Strategies for Construction and Demolition Waste Management in Kabul: A Comparative Analysis and Path Forward. *Afghan International Journal of Science 1*(1), 23-41. DOI: https://doi.org/10.66546/aijs.v1i1.7

Introduction

Construction and demolition (C&D) waste refers to waste generated during construction, renovation, demolition, or repair, including concrete, bricks, wood, glass, metals, plastics, and insulation materials (Shajidha & Mortula, 2025). There are significant challenges in managing this type of waste material, particularly in developing countries like Afghanistan. The quality of infrastructure and waste separation in Kabul is barely sufficient, which contributes to these challenges. Although considerable research has been conducted on the management of C&D waste in developed countries, little is known about how these strategies can be modified and implemented in rapidly urbanizing cities in the developing world, such as Kabul (Balasbaneh et al., 2025).

C&D waste encompasses a diverse range of materials that vary by construction type, materials used, and location. Common components include:

***Correspondence:** imransafi2021@gmail.com
Link: https://aijs.aiiu.edu.af/index.php/aijs/article/view/7

A significant portion of construction and demolitions (C&D) waste is concrete waste, including broken and unused components, which accounts for 30% to 70% of total waste (Patil et al., 2024). Construction and demolition (C&D) waste is generated during construction and demolition, and recycling these wastes reduces landfill use. Demolition sites are particularly high in the use of bricks and tiles, and Vietnam has reported that up to 31% of its construction and demolition (C&D) waste is composed of bricks and blocks (Hoang et al., 2020). Steel, aluminium, and copper also account for a large share of C&D waste. These plastics can be recycled, but their waste poses environmental hazards (Bonifazi et al., 2025). Wood and plastics, which are often used in doors, windows, piping, and insulation, are also sources of C&D waste, especially during demolition. An example of activities during excavation and site preparation that generate soil, sand, and gravel accounts for up to 36 percent of construction and demolition (C&D) waste. Although specific materials, such as concrete, can be recycled for construction and landscaping, improper disposal can lead to their accumulation in landfills (Elshaboury et al., 2022).

C&D waste is heterogeneous, making it difficult to manage and even recycle. Concrete is reusable, and in most cases, the metals can also be reused. The volume of C&D waste generated varies globally and depends on factors such as urbanization and local regulations (Luciano et al., 2022). It is well known that developing countries like Afghanistan often have poor waste management and related environmental degradation, and the same has been reported in other countries, such as Vietnam. C&D waste accounts for 10-15 percent of municipal solid waste, with 36 percent of that category in the form of soil, sand, and gravel. Construction and demolition waste (CDW) presents several significant hazards, including chemical contamination, airborne dust, noise, and physical injuries from sharp or heavy debris (Cook et al., 2022). These hazards can reach receptors through multiple pathways: inhalation of dust or toxic fumes, dermal contact with hazardous materials, ingestion of contaminated soil or water, and direct physical contact with waste (Figure 1) below.

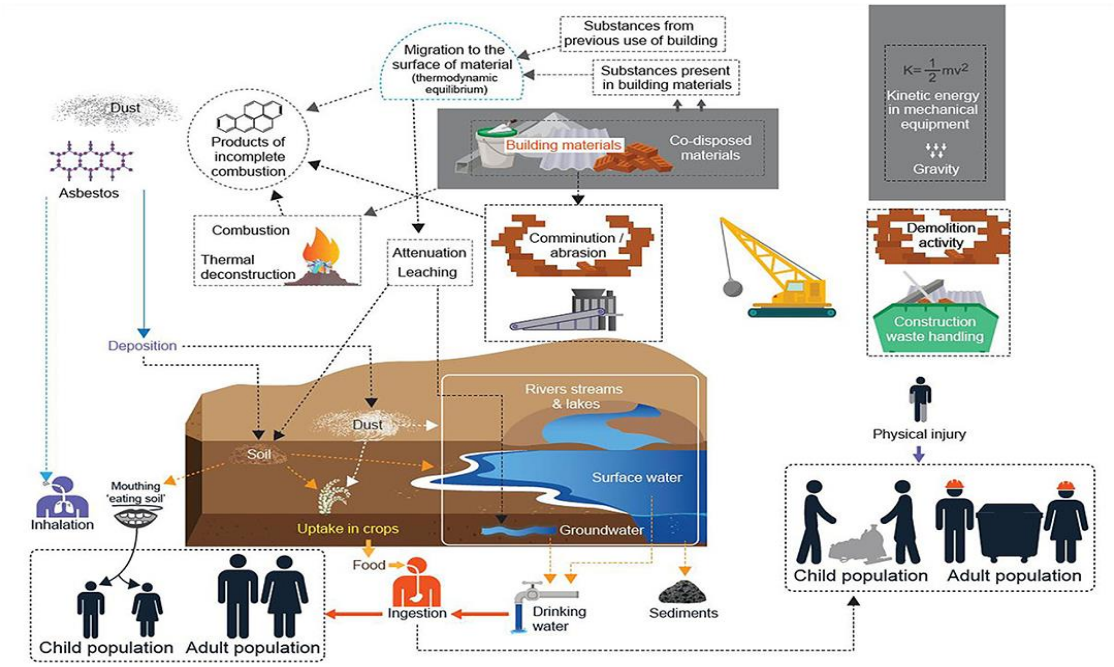

Figure 1. *Summary of the main hazards associated with construction and demolition waste (CDW) and the pathways through which they may result in exposure to receptors (Cook et al., 2022).*

To better understand the future trajectory of the construction and demolition (C&D) waste management sector, market growth projections are examined. As illustrated in Figure 2, the global C&D waste management market is expected to expand steadily over the 2024–2029 period. This projected growth reflects increasing regulatory pressure, rising construction activities, and a growing emphasis on sustainable waste management practices worldwide. The figure provides a quantitative overview of market development, highlighting the scale and pace of growth that may influence policy formulation and strategic planning in developing urban contexts such as Kabul.

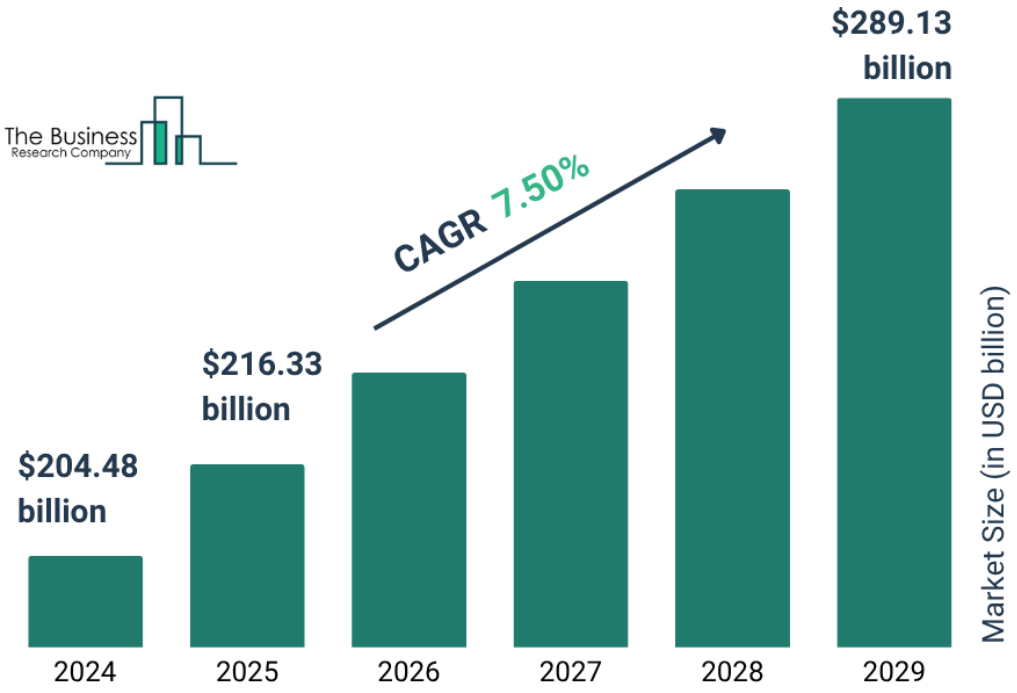

Figure 2. *Construction and Demolition Waste Management Global Market Report 2025*

Figure 2 shows the predicted growth of the construction and demolition (C&D) waste management market from 2024 to 2029, indicating steady growth. The market is projected to be $204.48 billion USD in 2024, growing annually to $289.13 billion USD by 2029, at a compound annual growth rate (CAGR) of 7.50%. This reflects a rising global focus on sustainable waste management systems in the construction and demolition sector, aligning with efforts to minimize environmental impact and improve resource utilization. This trend suggests that Kabul is moving toward more efficient and environmentally friendly waste systems.

Effective C&D waste management can create jobs, lower disposal costs, and supply reusable materials for construction. The 3R concept (reduce, reuse, recycle) has reduced waste in countries like Malaysia; applying similar methods in Kabul could lower disposal costs and enhance resource recovery. Such waste management supports sustainability and urban health, minimizes environmental impact, and offers economic benefits (Cook et al., 2022). Learning from international practices, Kabul could develop a more efficient waste management system.

The following table lists key studies on construction and demolition (C&D) waste control from different countries. These studies discuss a range of viewpoints, challenges, and remedies for recycling and disposal of C&D waste.

Table 1. *Key Studies on Construction and Demolition Waste Management and Circular Economy Practices*

No	Authors)	Year	Study Topic	Results
1	Menegaki& Damigos.	2018	A review of the current situation and challenges of construction and demolition waste management	This study discusses the challenges of managing C&D waste globally, focusing on the lack of standardized practices, recycling issues, and the limited integration of circular economy principles.
2	Agamuthu, P.	2008	Challenges in the sustainable management of construction and demolition waste	The study emphasizes the environmental impact of C&D waste and the lack of effective management strategies, particularly in developing countries.
3	Alshdiefat et al.	2025	Construction and demolition waste management in Jordan: a multifaceted perspective	This study highlights the challenges faced in Jordan, focusing on regulatory frameworks and the lack of coordination among stakeholders in C&D waste management.
4	Al-Raqeb et al.	2023	Understanding the challenges of construction demolition waste management towards circular construction: Kuwait stakeholders' perspective	The study assesses the challenges in Kuwait, including stakeholder engagement and the adoption of circular-economy principles, and proposes strategies for effective waste management.
5	Shooshtarian et al.	2022	An investigation into challenges and opportunities in the Australian construction and demolition waste management system	This research examines Australia's advanced C&D waste management systems, highlighting successful recycling strategies and the role of government policies.
6	Lockrey et al.	2016	Recycling the construction and demolition waste in Vietnam: opportunities and challenges in practice	This paper highlights the challenges of C&D waste management in Vietnam, including improper disposal practices and the need for improved recycling infrastructure.
7	Mahpour, A.	2018	Prioritizing barriers to adopting the circular economy in construction and demolition waste management	The paper identifies key barriers to adopting the circular economy in C&D waste management, focusing on economic, technological, and regulatory factors.
8	Ramos et al.	2023	Strategies to promote construction and demolition waste management in the context of local dynamics	This research emphasizes the role of local dynamics and tailored strategies in improving C&D waste management, with a focus on community involvement and legislative frameworks.
9	Esa et al.	2017	Developing strategies for managing construction and demolition wastes in Malaysia	This paper discusses how Malaysia is integrating the circular economy approach into its C&D waste management strategies, emphasizing

No	Authors)	Year	Study Topic	Results
			based on the concept of the circular economy	sustainable practices in the construction sector.
10	Purchase et al.	2021	Circular economy of construction and demolition waste: A literature review on lessons, challenges, and benefits	This literature review highlights the importance of circular economy principles for managing C&D waste and presents case studies of successful circular strategies.
11	Ma et al.	2020	Challenges in current construction and demolition waste recycling: A Chinese study	The study identifies key barriers to recycling, including insufficient waste sorting, insufficient financial incentives, and poor policy enforcement in China.
12	Jin et al.	2017	An empirical study of perceptions towards construction and demolition waste recycling and reuse in China	This study analyzes stakeholders' perceptions of recycling and reuse of C&D waste, highlighting a lack of awareness and insufficient infrastructure.
13	Islam et al.	2024	Review on sustainable construction and demolition waste management—challenges and research prospects	The paper reviews global trends in C&D waste management, emphasizing the need for sustainable practices, policy advancements, and the integration of modern technologies in recycling systems.
14	Van Tuan et al.	2018	Current status of construction and demolition waste management in Vietnam: Challenges and opportunities	This study examines the status of C&D waste management in Vietnam, highlighting challenges in waste segregation and the need for improved recycling infrastructure.
15	Iyiola et al.	2024	Digital technologies for promoting construction and demolition waste management: a systematic review	The review focuses on how digital technologies, such as BIM and AI, can enhance C&D waste management practices, making them more efficient and sustainable.
16	Yuan& Shen.	2011	Trend of the research on construction and demolition waste management	The paper reviews global trends in C&D waste management research and identifies a growing focus on waste reduction and recycling strategies.
17	Blaisi, N.I.	2019	Construction and demolition waste management in Saudi Arabia: Current practice and roadmap for sustainable management	This paper reviews current C&D waste management practices in Saudi Arabia and offers a roadmap for implementing more sustainable approaches.
18	Bonifazi et al.	2025	Current trends and challenges in construction and demolition waste recycling	The paper explores the latest trends in C&D waste recycling, identifying significant barriers and opportunities for increasing the effectiveness of recycling programs.

No	Authors)	Year	Study Topic	Results
19	Ferriz-Papi et al.	2024	Examining the challenges for circular economy implementation in construction and demolition waste management	This review examines the challenges the construction sector faces in implementing circular economy principles for C&D waste management, focusing on policy, technical, and cultural barriers.
20	López Ruiz et al.	2020	The circular economy in the construction and demolition waste sector – A review and an integrative model approach	The study reviews the circular economy model applied to C&D waste management and presents an integrative framework for implementing recycling strategies.
21	Yeheyis et al.	2013	An overview of construction and demolition waste management in Canada: a lifecycle analysis approach to sustainability	This paper provides a lifecycle analysis of C&D waste management in Canada, emphasizing the sustainability aspect and the need for efficient waste management strategies.
22	Oyenuga & Bhamidimarri.	2015	Sustainable approach to managing construction and demolition waste: an opportunity or a new challenge	The study explores sustainable practices, including the adoption of the 3R (reduce, reuse, recycle) principles, and the challenges of implementing them in the construction sector.
23	Kartam et al.	2004	Environmental management of construction and demolition waste in Kuwait	The study examines the environmental impact of C&D waste in Kuwait and discusses regulatory measures to improve waste-disposal practices.
24	Duan & Li	2016	Construction and demolition waste management: China's lessons	This study provides insights from China's evolving waste management policies, highlighting the impact of regulatory measures and the barriers to full implementation.
25	Kabirifar et al.	2021	A systematic review of construction and demolition waste management in Australia: Current practices and challenges	This systematic review examines the C&D waste management landscape in Australia, highlighting the country's advanced recycling systems and challenges in waste reduction.

The current literature review was conducted in accordance with established criteria. These criteria were designed to assess the relevance, quality, and applicability of such insights, which can be used to make accurate comparisons and cluster countries with issues equivalent to those in Kabul. These obstacles are described as significant hindrances to the proper management of waste materials.

The review revealed that other countries, such as Kuwait and Malaysia, have better systems for construction and demolition (C&D) waste management. In contrast, Vietnam and Afghanistan experience persistent illegal dumping and inadequate recycling. These findings identified

critical weaknesses in Kabul's practices and highlighted solutions demonstrated in more developed systems.

The analysis identified key obstacles to effective C&D waste management, including insufficient enforcement of regulations, limited recycling incentives, minimal stakeholder involvement, and inadequate infrastructure. These challenges are evident in Kabul, where awareness is low, policies are fragmented, and the quality of waste collection is poor. The findings confirm that Kabul's situation is representative of similar contexts.

The synthesized findings offer a comprehensive global perspective on C&D waste management, emphasizing best practices relevant to Kabul. While advanced technologies such as Building Information Modelling (BIM) may eventually benefit Kabul, immediate challenges require urgent action. The results present actionable improvements, supported by successful international examples.

Methods and Materials

This study adopts a qualitative review-based research methodology to examine the challenges and strategies for construction and demolition (C&D) waste management in Kabul, Afghanistan, and compare them with selected international practices. Given the absence of comprehensive primary datasets and structured monitoring systems for C&D waste in Kabul, the research relies exclusively on secondary data obtained from peer-reviewed academic literature and authoritative reports.

A systematic literature search was conducted across major academic databases, including Web of Science, ScienceDirect, SpringerLink, and Google Scholar. Keywords and search strings included "construction and demolition waste management," "Challenges in sustainable management of construction and demolition waste," "C&D waste recycling," "circular economy in construction," "waste segregation," "policy enforcement," and "developing countries," with additional geographic references to Afghanistan and Kabul where available. Only English-language publications published between 2004 and 2025 were considered to ensure relevance and methodological reliability.

The selection of studies followed predefined inclusion and exclusion criteria. Included sources comprised peer-reviewed journal articles, systematic reviews, and policy-oriented studies addressing C&D waste generation, recycling practices, regulatory frameworks, economic instruments, stakeholder engagement, and technological interventions. Excluded materials included non-peer-reviewed publications, opinion-based articles, studies unrelated to construction waste, and sources lacking analytical or methodological rigor. Based on this screening process, Sixty-five core studies were selected to form the analytical foundation of the review.

To contextualize Kabul's C&D waste management challenges, a comparative case analysis was conducted using examples from Australia, Kuwait, Vietnam, and Malaysia. These countries were selected for their diverse regulatory environments, levels of recycling infrastructure, and relevance to both developed and developing urban contexts. The comparison enabled the

identification of transferable policy instruments and operational strategies applicable to Kabul's institutional and socio-economic conditions.

Thematic analysis was the primary tool used in the literature review. Categorizing research into distinct themes (such as waste generation, recycling methods, and policy enforcement) enabled more explicit comparisons and the identification of key trends. Content comparison assessed selected studies to distinguish overlaps and differences in both the challenges and strategies related to C&D waste management. This approach enabled direct comparison between Kabul and other cities facing similar issues. Qualitative synthesis unified core findings and supported actionable recommendations for Kabul. The aim was to present a comprehensive analysis of the challenges and solutions for C&D waste management in Kabul, utilizing case studies from other countries as evidence.

Findings & Discussion

A literature review shows that unstandardized practices in Construction and Demolition (C&D) waste management in developing nations, such as Kabul, have caused serious environmental and operational issues. In Vietnam, Iran, and Afghanistan, waste separation and recycling facilities are not always adequate in the urban areas. In such situations, no structured recycling methods are established, and as a result, they are disposed of informally or even sent to a landfill. Moreover, the absence of effective management plans worsens environmental pollution and the improper use of resources. Unlike this, Japan and Australia have introduced stringent measures to minimize C&D waste, encourage recycling, and reduce landfill use. The main characteristics of such policies are the separation of the sources, increased recycling rates, and sustainable construction. On the same note, Malaysia and Kuwait consider the principles of circular economy in the construction and demolition (C&D) waste industry, prioritizing the exploitation of resources and reduction of environmental impact (Esa et al., 2017; Al-Raqeb et al., 2023). Figure 4 reveals the composition of waste in an unspecified area.

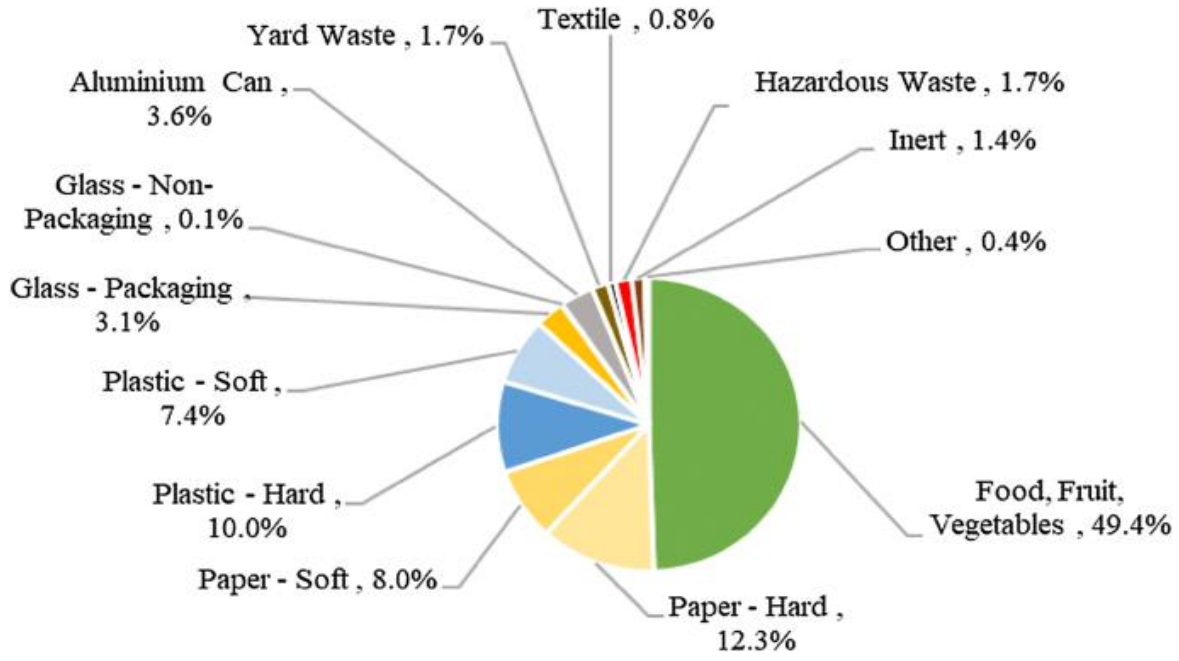

Figure 4. *Integrated solid-waste management for Kabul city, Afghanistan*

It shows the proportions of different types of waste, including food, fruit, and vegetables, with the highest at 49.4%. Others that contribute prominently include paper (hard), 12.3%, plastic (hard), 10%, and plastic (soft), 7.4%. Smaller recyclables include aluminium cans, glass bottles, hazardous waste, and yard waste.

The chart provides information on the waste to be collected and recycled. The food and organic waste flows in Kabul are likely to be large, and proper waste collection methods, reuse, recycling, and composting should be implemented. It may also be more sustainable through better waste segregation, increased awareness, and the recycling of materials such as paper, plastic, and aluminium, by improving waste management within the city.

C&D Waste Management Problems in Kabul

Kabul city faces construction and demolition (C&D) waste, and problems include inadequate infrastructure, poor regulatory frameworks, and inadequate social education. The issue of improperly separated waste on construction sites is also a problem in the city, which leads to a mix of materials that are not easily recycled or reused.

Poor management of waste has contributed to increased landfill use and environmental degradation, as waste is disposed of illegally or recklessly. On the one hand, the absence of dedicated sorting zones at construction and demolition sites significantly worsens the challenge of diverting materials from landfills, thereby undermining the effective recycling of generated debris. In their absence, functional materials such as metals, plastics, and concrete are not separable, and the waste is usually dumped in landfills, which, besides overcrowding space, affects potential recyclable products (Esa et al., 2017; Al-Raqeb et al., 2023).

The absence of C&D waste segregation at construction sites makes the recycling process more complex and expensive. Consequently, large amounts are thrown in dumping sites, thus wasting resources and causing more pollution. The lack of proper recycling systems also leads to increased use of raw materials in construction in Kabul. In addition, there are no integrated policies and regulations to help manage C&D waste in Kabul. Unlike countries such as Kuwait and Malaysia, which implement incentive-based recycling policies that eliminate taxes and provide government subsidies to companies recycling C&D materials (Shajidha & Mortula, 2025), Kabul lacks comparable policy frameworks.

Regulations promoting recycling in these countries not only reduce waste but also advance sustainability by motivating the construction industry to adopt more environmentally friendly practices. Recycling tax breaks, subsidies, and financial incentives have been effective in reducing waste products generated and investing in sustainable waste management systems within enterprises (Shooshtarian et al., 2022). However, in Kabul, where there is no policy to promote or even compel recycling, there is little reason for construction companies to take any action to reduce the rubbish they produce or to recycle. Kabul lacks a robust waste policy framework and does not require construction companies to minimize waste or prioritize recycling. As a result, most projects overlook waste management, hindering the transition to a circular economy and delaying the implementation of sustainable strategies that could mitigate ecological impacts.

Comparative Analysis in International Practices

Comparing Kabul with countries such as Vietnam, Iran, and Kuwait demonstrates both the challenges and the progress possible for Kabul. Vietnam faces issues with illegal dumping and low recycling rates, but it utilizes government initiatives to increase awareness and improve segregation (Ramos et al., 2023). Iran faces challenges with waste disposal, but recent laws introducing fees and incentives have effectively promoted recycling and reduced waste levels. Kuwait shows that strong government policies and incentives can drive recycling and sustainability. By applying circular economy principles, enterprises have made significant progress in increasing recycling rates and promoting environmental stewardship. Kabul may similarly advance its waste management regimen by adopting targeted policy reforms, especially within the construction sector.

Malaysia serves as a pertinent case study, demonstrating how circular-economy measures can effectively mitigate construction and demolition (C&D) waste. The Malaysian model employs a dual system of economic incentives for recycling and administrative fines for unlawful disposal, resulting in reduced landfill volumes and increased material recovery rates. Kabul may replicate these programmes, augmenting them with robust public awareness campaigns, to catalyse a parallel evolution in its C&D waste sector.

Kabul exhibits a substantial deficit in waste management when assessed against internationally recognized benchmarks for C&D debris. Inadequate collection frameworks, ineffective segregation practices, and the intermittent enforcement of recycling and disposal directives have led to widespread unlawful dumping and associated environmental harm. In marked contrast, mature economies such as Japan and Australia have established rigorous policy architectures that prioritize waste prevention and systematically promote sustainable operational practices throughout the construction supply chain.

Plans of Enhancement in C&D Waste Management

Kabul's rapid urbanization generates substantial construction and demolition (C&D) waste, the mismanagement of which aggravates environmental decline and depletes vital material resources, thereby compromising sustainability objectives. Successful diversion, treatment, and reuse of C&D waste, however, continue to falter owing to the absence of coherent statutory frameworks, the limited domestic technological base, insufficient public understanding of waste-related hazards, and the widespread absence of sustainable building practices (Hoang et al., 2020). These multidimensional barriers necessitate an integrated intervention that encompasses mutually reinforcing intentional policy instruments, catalytic technological innovation, systematic public outreach, and the systemic promotion of environmentally responsible building design. Accordingly, the following actions outline the operational and instrumental measures needed to enhance C&D waste management in the Kabul metropolitan area, thereby promoting sustainable urbanization.

Policy and Regulatory Framework

Policy innovation in construction and demolition (C&D) waste management should encompass key steps: managing waste generation, sorting at the source, promoting recycling, and properly disposing of the remaining waste (Wu et al., 2020). Weak controls at these points hurt Kabul's

sustainability and put its long-term urban goals at risk. So, introducing clear, step-by-step rules for handling off-site debris is a practical way to improve Kabul's current patchy approach to waste disposal.

Charging a waste disposal fee is one example of a targeted approach that has been effective in countries such as Australia and Japan, where it has supported rising recycling rates (Di Maria et al., 2018). If a similar fee were applied to Kabul's construction firms, with charges based on debris type and weight, it could provide strong incentives to reduce waste and divert more of it toward higher-quality recycling streams, such as those for quarry materials and aluminium.

Such charges would provide financial motivation for construction firms to minimize waste production and improve recycling rates. Disposal charges can be used to fund the creation of a recycling facility and a waste management facility in the city.

Recycling Incentives

C&D waste management is an important policy intervention that provides incentives for recycling. Certain countries, such as Kuwait, allow companies involved in the recycling of construction and demolition (C&D) materials to receive tax exemptions or financial assistance (Hua et al., 2022). Such incentives should be applied in Kabul to encourage the construction industry to focus on recycling. An example would be subsidizing the recycling of concrete, metals, and other recoverable materials. Furthermore, regulatory frameworks should be unequivocal, mandating protocols that clearly distinguish recyclables from general refuse, thereby optimizing resource recovery and minimizing contamination.

To reduce waste generation at its source, the overarching waste management policy must mandate continuous efforts to abate material inflows. Large-scale construction undertakings could be required to submit detailed waste management proposals specifying quantified targets for source reduction, material recovery, and recycling across the project lifecycle (Zorpas, 2020). Empirical evidence from regulatory regimes in the United States, the United Kingdom, and Australia demonstrates that mandatory waste management plans substantially restrict the volume and environmental impact of construction waste. By establishing comparable expectations, Kabul can cultivate a culture of accountability whereby construction firms practice diligent resource stewardship.

Innovation and Technology Interventions

The management of construction and demolition waste in Kabul can be substantially advanced through the systematic deployment of technology and innovative practices. Leveraging modern analytical tools, mobile recovery systems, and data-driven operational protocols can enhance resource efficiency, significantly reduce unit processing and transportation costs, and broaden the volume of recoverable material from demolition and construction debris, thus embedding a circular economy in the sector.

Several emerging technologies can now streamline waste management operations. Construction Waste Tracking Systems constitute a pivotal development. By employing real-time, site-level surveillance, these systems facilitate continuous oversight of waste volume, recycling rates, and final disposal modes. RFID or barcode technology, when deployed on material loads, enables operators to register and track resource movements throughout the

lifecycle of a construction or demolition project (Zhao et al., 2019). System-generated databases subsequently deliver granular reports on waste characteristics and quantities, thereby furnishing decision-makers with a solid evidence base to calibrate waste prevention, resource recovery, and on-site organizational practices. In Kabul, the large-scale introduction of waste tracking could empower municipal authorities to oversee compliance, foreground management deficiencies, and target future regulatory and infrastructural upgrades.

A critical constraint to effective management of construction and demolition (C&D) waste in Kabul remains the limited network of fixed recycling plants. A pragmatic solution is to deploy a portable, modular recycling apparatus. Mobile crushers, for instance, can reprocess concrete and mixed debris directly on-site, reducing haulage distances, lowering fuel costs, and accelerating the recycling workflow (Purchase et al., 2021). Complementing this, automated sorting technologies have demonstrated efficiency in disaggregating ferrous and non-ferrous metals, plastics, and wood fiber; these solutions already yield measurable environmental dividends and elevated revenue flows in the recycling environments of Japan and Singapore.

Building Information Modelling (BIM) represents a transformative advancement in holistic construction and demolition (C&D) waste management throughout the facility's life cycle (Han et al., 2021). By generating a detailed, spatially explicit digital model of the structure, project teams can simulate and assess waste logistics long before breaking ground. The framework enables the precise delineation of material freight sequences, thereby minimizing manufactured excess and supporting the early identification of deconstruction sequences, thereby significantly curbing the projected waste yield (Jalaei et al., 2019).

Public Education and Stakeholder Development

The effective management of construction and demolition (C&D) waste relies on the purposeful engagement of stakeholders and widespread public education; neither regulation nor compliance can be sustained in contexts where the population lacks information or motivation (Du et al., 2020). Information channels must therefore reach and persuade construction enterprises, public authorities, and civil-society organizations simultaneously, ensuring that waste minimization and recycling become embedded priorities across the entire sector.

An immediate priority action in Kabul must be the systematic instruction of: builder actors and the wider public. Knowledge-transfer initiatives should be interdisciplinary, involving governmental bodies or non-governmental organizations that present empirical evidence of the detrimental consequences of careless disposal, balanced by the quantifiable advantages of material recovery (Menegaki and Damigos, 2018). Australian precedents demonstrate that carefully designed outreach can break stereotypes and spur the adoption of ecologically sound management practices. Kabul could replicate such strategies by integrating multimedia messaging, tailored workshops, and structured vocational modules; the combination will cultivate a shared, practical grasp of solid-waste principles, thereby anchoring sustainability↵ in actual market and civic behaviour.

Stakeholder engagement in the formulation and operational oversight of waste management frameworks enhances the effectiveness of policy translation mechanisms. Australia's

performance in diverting construction and demolition (C&D) waste highlights the benefits of collaborative governance, which involves federal, state, and local actors, as well as industry representatives and civil society (Shooshtarian et al., 2022). A mirrored model for Kabul could be realized through the establishment of strategic coalitions comprising relevant ministries, construction enterprises, and licensed waste management service providers, thereby facilitating the reciprocal exchange of standards, the co-design of pilot interventions, and the synchronized scheduling of diversion tasks across urban districts.

Sustainable design and construction protocols presently serve as the primary catalyst for curtailing C&D material surpluses. Integrated decision frameworks that prioritize waste avoidance at the conceptual phase significantly depress the volume of residual material arising from subsequent construction and decommissioning. Off-site modular prefabrication—entailing the factory fabrication of standardized, site-specific assemblies, succeeded by rapid on-location erection—substantially curtails the embodied surplus occasioned by in situ carpentry, forming, and cutting. Numerous data-cited jurisdictions, notably the United States and the United Kingdom, report decreased on-site waste and accelerated programming courtesy of modular intensification. Kabul policy can thereby endorse prefabricated assemblies in the prioritized rebuilding of administrative, transport, and health infrastructures, advancing circular aims and improving budgetary predictability while concurrently diffusing low-key technical skill advancements.

Prefabrication and deconstruction (P&D) in building design let architects specify ways to reuse or recycle components after use (Eckelman et al., 2018). Designing for disassembly (DfD) changes material and assembly choices, favouring methods that allow careful separation and reuse. Implementing a Design for Deconstruction (DfD) framework in Kabul could substantially reduce construction and demolition (C&D) waste by promoting a more regulated demolition process. DfD is an approach that anticipates the eventual dismantling of buildings to enable the efficient recovery of their materials. Such a strategy facilitates the organized recovery and subsequent recycling of salvageable materials, allowing for the efficient extraction of valuable resources, including ferrous (iron-based) and non-ferrous (non-iron-based) metals, fine and coarse aggregates (different sizes of crushed stones or sand used in construction), various polymeric composites (combinations of plastics), and demolished concrete.

Conclusion

Kabul remains vulnerable to the compounding pressures of C&D waste, primarily due to a mutually reinforcing triad of inadequate processing capacities, ineffective source-separation behaviours (i.e., sorting different waste types at the point of origin), and the absence of legal and institutional frameworks capable of mandating recycling and minimizing residual waste. This trio of constraints cultivates unabated environmental deterioration alongside the systemic undervaluation of reusable materials. The immediate mitigation of these entrenched impediments depends on the expeditious enactment of a statutory instrument establishing measurable, auditable performance benchmarks for recycling as a primary waste-governance directive. Infrastructure upgrades—specifically, the installation of mechanized, tiered sorting and destruction units (machines that automate sorting and break down waste)—are a

precondition for increasing resource recovery yields. Parallel to hardware investments, the promulgation of design protocols that prioritize modular construction (utilizing prefabricated sections) and off-site assembly (constructing building parts at a separate location) will help mitigate waste generation at the design and procurement stages. A fundamental transformation, framed through circular-economy precepts (principles emphasizing continuous resource use), promises an integrated circuit that maximizes resource liberation, attenuates waste embodied in materials, and diminishes the construction sector's inherent energy footprint. By integrating proximal reforms with anticipatory measures, the city can establish a resilient waste-management apparatus capable of addressing environmental, economic, and public health imperatives.

Recommendations

Kabul must institute a transparent institutional architecture for the governance of construction and demolition waste, undergirded by comprehensive statutory provisions that impose unambiguous obligations upon project stakeholders to maximize recovery, employ environmentally sound disposal routes, and adopt waste-mitigation measures at all phases of the building continuum (covering every stage from design and construction to demolition).

1. An explicit enforcement framework must be established to underpin compliance and accountability across the construction sector, thereby mitigating negative externalities and promoting the sustainable use of resources.
2. Kabul must establish specialized recycling centres for construction and demolition waste if the city is to achieve comprehensive and integrated management of this growing stream of material. Regional facility networks, fed by strategic clusters of urban demolition and construction sites, will also enhance the economic and environmental performance of urban material recovery.
3. Implementation of advanced mechanized sorting operations—such as mobile aggregate mills, which crush and grade reinforced concrete in the original demolition zone, and programmable belt scanners that opto-electronically classify, remove, and bale steel, wood, glass, and plastics—will achieve substantial fragmentation and separation efficiency, thereby minimizing the volume to landfill.
4. The growth of this enhanced processing capacity will send a clear economic signal to producers: construction firms must increasingly account for formerly free societal costs, including air and groundwater contamination, excess landfill fiscal and reputational liabilities, and impediments to soil formation, encouraging the ongoing adoption of environmentally responsible material and service procurements. Concrete performance targets should include continual diversion rates away from landfills, escalating recovery indices for reusable resource streams, and ambitious waste minimization targets. Furthermore, incorporating circular economy objectives into the city's building codes is crucial for establishing and enforcing precise, audit-capable, and punitive compliance mechanisms.
5. Kabul needs flexible waste governance to address operational disruptions and enhance infrastructure resilience as conditions evolve.

6. Set concrete milestones, assign responsibilities to key agencies, and use specific performance indicators tailored to Kabul's context to measure progress.

Authors Contributions

- Imran Safi was responsible for the conceptualization, design, and writing of this article, including data collection, literature review, and preparation of the initial manuscript draft.
- Abdulhai Kaiwaan and Arif Naimzad critically reviewed the manuscript, provided substantial feedback, and contributed to revisions that improved the quality and clarity of the final paper.
- All authors reviewed and approved the final version.

References

Agamuthu, P. (2008). Challenges in sustainable management of construction and demolition waste. *Waste Management & Research, 26*(6), 491-492. https://doi.org/10.1177/0734242X08100096

Al-Otaibi, A., Bowan, P. A., Abdel daiem, M. M., Said, N., Ebohon, J. O., Alabdullatief, A., Al-Enazi, E., & Watts, G. (2022). Identifying the barriers to sustainable management of construction and demolition waste in developed and developing countries. Sustainability, 14(13), 7532. https://doi.org/10.3390/su14137532

Al-Raqeb, H., Ghaffar, S.H., Al-Kheetan, M.J., & Chougan, M. (2023). Understanding the challenges of construction demolition waste management towards circular construction: Kuwait stakeholder's perspective. *Cleaner Waste Systems, 4*, 100075. https://doi.org/10.1016/j.clwas.2023.100075

Alshdiefat, A.A.S., Sharif, A.A., Alharahsheh, A.I., Albrka, S.I., Olsson, N.O., Younes, M., & Bang, S. (2025). Construction and demolition waste management in Jordan: A multifaceted perspective. *Construction Innovation, 25*(2), 290-305. https://doi.org/10.1108/CI-08-2022-0221

Alite, M., Abu-Omar, H., Agurcia, M.T., Jácome, M., Kenney, J., Tapia, A., & Siebel, M. (2023). Construction and demolition waste management in Kosovo: A survey of challenges and opportunities on the road to circular economy. *Journal of Material Cycles and Waste Management*, 25(2), 1191-1203. https://doi.org/10.1007/s10163-022-01577-5

Balasbaneh, A. T., Sher, W., Li, J., et al. (2025). Systematic review of construction waste management scenarios: Informing life cycle sustainability analysis. Circular Economy and Sustainability, 5, 529–553. https://doi.org/10.1007/s43615-024-00424-z

Blaisi, N.I. (2019). Construction and demolition waste management in Saudi Arabia: Current practice and roadmap for sustainable management. *Journal of Cleaner Production, 248*, 119238. https://doi.org/10.1016/j.jclepro.2019.119238

Bonifazi, G., Grosso, C., Palmieri, R., & Serranti, S. (2025). Current trends and challenges in construction and demolition waste recycling. Current Opinion in Green and Sustainable Chemistry, 53, 101032. https://doi.org/10.1016/j.cogsc.2025.101032

Chen, J., Su, Y., Si, H., & Chen, J. (2018). Managerial areas of construction and demolition waste: A scientometric review. *International Journal of Environmental Research and Public Health, 15*(11), 2350. https://doi.org/10.3390/ijerph15112350

Cook, E., Velis, C. A., & Black, L. (2022). Construction and demolition waste management: A systematic scoping review of risks to occupational and public health. Frontiers in Sustainability, 3, Article 924926. https://doi.org/10.3389/frsus.2022.924926

Duan, H., & Li, J. (2016). Construction and demolition waste management: China's lessons. *Waste Management & Research, 34*(5), 397-398. https://doi.org/10.1177/0734242X16647603

Du, L., Feng, Y., Lu, W., Kong, L., & Yang, Z. (2020). Evolutionary game analysis of stakeholders' decision-making behaviours in construction and demolition waste management. *Environmental Impact Assessment Review, 84,* 106408. https://doi.org/10.1016/j.eiar.2020.106408

Di Maria, A., Eyckmans, J., & Van Acker, K. (2018). Downcycling versus recycling of construction and demolition waste: Combining LCA and LCC to support sustainable policy making. *Waste Management, 75,* 3–21. https://doi.org/10.1016/j.wasman.2018.01.028

Eckelman, M. J., Brown, C., Troup, L. N., Wang, L., Webster, M. D., & Hajjar, J. F. (2018). Life cycle energy and environmental benefits of novel design-for-deconstruction structural systems in steel buildings. *Building and Environment, 143,* 421–430. https://doi.org/10.1016/j.buildenv.2018.07.017

Esa, M.R., Halog, A., & Rigamonti, L. (2017). Developing strategies for managing construction and demolition wastes in Malaysia based on the concept of circular economy. *Journal of Materials Cycles and Waste Management, 19*, 1144-1154. https://doi.org/10.1007/s10163-016-0516-x

Ferriz-Papi, J.A., Lee, A., & Alhawamdeh, M. (2024). Examining the challenges for circular economy implementation in construction and demolition waste management: A comprehensive review using systematic methods. *Buildings, 14*(5), 1237. https://doi.org/10.3390/buildings14051237

Han, D., Kalantari, M., & Rajabifard, A. (2021). Building Information Modeling (BIM) for construction and demolition waste management in Australia: A research agenda. *Sustainability, 13*(23), 12983. https://doi.org/10.3390/su132312983

Hua, C., Liu, C., Chen, J. (2022). Promoting construction and demolition waste recycling by using incentive policies in China. Environmental Science and Pollution Research, 29, 53844–53859. https://doi.org/10.1007/s11356-022-19536-w

Hoang, N. H., Ishigaki, T., Kubota, R., Tong, T. K., Nguyen, T. T., Nguyen, H. G., Yamada, M., & Kawamoto, K. (2020). Waste generation, composition, and handling in building-related construction and demolition in Hanoi, Vietnam. *Waste Management, 117*, 32–41. https://doi.org/10.1016/j.wasman.2020.08.006

Islam, N., Sandanayake, M., Muthukumaran, S., & Navaratna, D. (2024). Review on sustainable construction and demolition waste management—challenges and research prospects. *Sustainability, 16*(8), 3289. https://doi.org/10.3390/su16083289

Iyiola, C. O., Shakantu, W., & Daniel, E. I. (2024). Digital technologies for promoting construction and demolition waste management: A systematic review. *Buildings, 14*(10), 3234. https://doi.org/10.3390/buildings14103234

Jin, R., Li, B., Zhou, T., Wanatowski, D., & Piroozfar, P. (2017). An empirical study of perceptions towards construction and demolition waste recycling and reuse in China. Resources, *Conservation and Recycling, 126*, 86-98. https://doi.org/10.1016/j.resconrec.2017.07.034

Kabirifar, K., Mojtahedi, M., & Wang, C.C. (2021). A systematic review of construction and demolition waste management in Australia: Current practices and challenges. *Recycling, 6*(2), 34. https://doi.org/10.3390/recycling6020034

Kartam, N., Al-Mutairi, N., Al-Ghusain, I., & Al-Humoud, J. (2004). Environmental management of construction and demolition waste in Kuwait. *Waste Management, 24*(10), 1049-1059. https://doi.org/10.1016/j.wasman.2004.06.003

Lai, D., Demartino, C., & Xiao, Y. (2021). High-strain rate compressive behavior of Fiber-Reinforced Rubberized Concrete. *Construction and Building Materials, 319*, 125739. https://doi.org/10.1016/j.conbuildmat.2021.125739

Lockrey, S., Nguyen, H., Crossin, E., & Verghese, K. (2016). Recycling the construction and demolition waste in Vietnam: Opportunities and challenges in practice. *Journal of Cleaner Production, 133*, 757-766. https://doi.org/10.1016/j.jclepro.2016.05.175

López Ruiz, L. A., Roca Ramón, X., & Gassó Domingo, S. (2019). The circular economy in the construction and demolition waste sector – A review and an integrative model approach. *Journal of Cleaner Production*, 248, 119238. https://doi.org/10.1016/j.jclepro.2019.119238

Luciano, A., Cutaia, L., Altamura, P., & Penalvo, E. (2022). Critical issues hindering a widespread construction and demolition waste (CDW) recycling practice in EU countries and actions to undertake: The stakeholder's perspective. *Sustainable Chemistry and Pharmacy, 29*, 100745. https://doi.org/10.1016/j.scp.2022.100745

Ma, M., Tam, V.W., Le, K.N., & Li, W. (2020). Challenges in current construction and demolition waste recycling: A China study. *Waste Management, 118*, 610-625. https://doi.org/10.1016/j.wasman.2020.09.030

Mahpour, A. (2018). Prioritizing barriers to adopt circular economy in construction and demolition waste management. *Resources, Conservation and Recycling, 134*, 216-227. https://doi.org/10.1016/j.resconrec.2018.01.026

Menegaki, M., & Damigos, D. (2018). A review on current situation and challenges of construction and demolition waste management. *Current Opinion in Green and Sustainable Chemistry, 13*, 8-15. https://doi.org/10.1016/j.cogsc.2018.02.010

Oyenuga, A.A., & Bhamidimarri, R. (2015). Sustainable approach to managing construction and demolition waste: An opportunity or a new challenge. *International Journal of Innovative Research in Science, Engineering and Technology, 4*(11), 10368-10378. https://doi.org/10.15680/IJIRSET.2015.0411007

Patil, Y. R., Dakwale, V. A., & Ralegaonkar, R. V. (2024). Recycling construction and demolition waste in the sector of construction. *Advances in Civil Engineering*. https://doi.org/10.1155/2024/6234010

Purchase, C.K., Al Zulayq, D.M., O'Brien, B.T., Kowalewski, M.J., Berenjian, A., Tarighaleslami, A.H., & Seifan, M. (2021). Circular economy of construction and demolition waste: A literature review on lessons, challenges, and benefits. *Materials, 15*(1), 76. https://doi.org/10.3390/ma15010076

Ramos, M., Martinho, G., & Pina, J. (2023). Strategies to promote construction and demolition waste management in the context of local dynamics. *Waste Management, 162*, 102-112. https://doi.org/10.1016/j.wasman.2023.02.028

Soyinka, O.A., Wadu, M.J., Lebunu Hewage, U.W.A., & Oladinrin, T.O. (2023). Scientometric review of construction demolition waste management: A global sustainability perspective. *Environment, Development and Sustainability, 25*(10), 10533-10565. https://doi.org/10.1007/s10668-022-02537-7

Shooshtarian, S., Caldera, S., Maqsood, T., Ryley, T., & Khalfan, M. (2022). An investigation into challenges and opportunities in the Australian construction and demolition waste management system. *Engineering, Construction and Architectural Management, 29*(10), 4313-4330. https://doi.org/10.1108/ECAM-05-2021-0439

Shajidha, H., & Mortula, M. M. (2025). Sustainable waste management in the construction industry. *Frontiers in Sustainable Cities, 7*, Article 1582239. https://doi.org/10.3389/frsc.2025.1582239

The Business Research Company. (2025). Construction and demolition waste management global market report 2025 – By service (collection, recycling, landfill, incineration), by business (construction, renovation, demolition), by waste (inert, wood, cardboard, plastic, glass, other wastes), by application (commercial buildings, residential buildings) – Impact of tariff and trade war on market size, growth, trends, and forecast 2025–2034. https://www.thebusinessresearchcompany.com/report/construction-and-demolition-waste-management-global-market-report

Ullah, S., Bibi, S.D., Ali, S., Noman, M., Rukh, G., Nafees, M.A., Bibi, H., Qiao, X.C., Khan, S., & Hamidova, E. (2022). Analysis of municipal solid waste management in

Afghanistan, current and future prospects: A case study of Kabul City. *Applied Ecology & Environmental Research, 20*(3). http://dx.doi.org/10.15666/aeer/2003_24852507

Van Tuan, N., Kien, T.T., Huyen, D.T.T., Nga, T.T.V., Giang, N.H., Dung, N.T., Isobe, Y., Ishigaki, T., & Kawamoto, K. (2018). Current status of construction and demolition waste management in Vietnam: Challenges and opportunities. *GEOMATE Journal, 15*(52), 23-29. https://doi.org/10.21660/2018.52.7194

Visvanathan, C., & Norbu, T. (2006, September). Reduce, reuse, and recycle: The 3Rs in South Asia. In 3 R South Asia Expert Workshop. https://d1wqtxts1xzle7.cloudfront.net/79229487/3R-SA-key-note-libre.pdf?1642751618

Wu, Z., Yu, A.T., & Poon, C.S. (2020). Promoting effective construction and demolition waste management towards sustainable development: A case study of Hong Kong. *Sustainable Development*, *28*(6), 1713-1724. https://doi.org/10.1002/sd.2119

Yeheyis, M., Hewage, K. N., Alam, M. S., & Eskicioglu, C. (2012). An overview of construction and demolition waste management in Canada: A lifecycle analysis approach to sustainability. *Clean Technologies and Environmental Policy*, *15*(1), 81-91. https://doi.org/10.1007/s10098-012-0481-6

Yuan, H., & Shen, L. (2011). Trend of the research on construction and demolition waste management. *Waste Management*, *31*(4), 670-679. https://doi.org/10.1016/j.wasman.2010.10.030

Zhao, X., Webber, R., Kalutara, P., Browne, W., & Pienaar, J. (2022). Construction and demolition waste management in Australia: A mini-review. *Waste Management & Research*, *40*(1), 34-46. https://doi.org/10.1177/0734242X211029446

Zhao, J., Seppänen, O., Peltokorpi, A., Badihi, B., & Olivieri, H. (2019). Real-time resource tracking for analyzing value-adding time in construction. *Automation in Construction, 104*, 52–65. https://doi.org/10.1016/j.autcon.2019.04.003

Zorpas, A. A. (2020). Strategy development in the framework of waste management. *Science of The Total Environment, 716*, 137088. https://doi.org/10.1016/j.scitotenv.2020.137088