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Waste Management in Construction and Its Challenges in Iran

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***Abstract*:** Effective waste management in construction is a cornerstone of sustainable development, especially in rapidly urbanizing countries like Iran. Despite its growing construction sector, Iran faces significant challenges in managing construction waste due to limited infrastructure, weak enforcement of regulations, and socio-cultural barriers. This study examines the current state of construction waste management in Iran, identifying key challenges such as inadequate recycling systems, lack of public awareness, and inefficient policy implementation. Using a multidisciplinary approach, the research highlights the environmental and economic impacts of poor waste management and proposes strategic solutions, including policy reforms, technological advancements, and educational initiatives. The findings aim to support stakeholders in fostering sustainable construction practices and improving waste management systems in Iran.

Keywords: Construction waste management, Sustainable development, Recycling systems, Regulatory challenges, Iran.

I. INTRODUCTION

Waste management is a critical component of sustainable construction practices, particularly in the context of environmental conservation and resource optimization (Shen et al., 2004). Globally, the construction sector is recognized as a major generator of solid waste, contributing significantly to environmental degradation when waste is not managed efficiently (Udawatta et al., 2015). This challenge is particularly pronounced in developing countries, where rapid urbanization, limited regulatory frameworks, and inadequate waste management infrastructure exacerbate the issue (Lu & Yuan, 2011).

Effective waste management in construction refers to the systematic processes of minimizing, handling, and properly disposing of waste generated during construction activities (Yuan, 2013a). This includes reducing waste at the source, reusing materials where possible, and recycling waste to divert it from landfills (Lu & Tam, 2013). The goal is to promote sustainability, reduce environmental harm, and optimize resource utilization while maintaining cost efficiency and adhering to regulatory standards (Wahi et al., 2016). Construction waste can include a wide range of materials such as concrete, wood, metal, plastic, and hazardous substances, all of which require careful management to mitigate their impact on the environment (Lu & Tam, 2013). One of the key principles of effective waste management is reduce, reuse, recycle framework (Kabirifar et al., 2020). Reducing waste generation involves careful planning and design to minimize excess material use, while reusing materials entails salvaging usable components from construction and demolition activities for new projects (Mills et al., 1999). Recycling focuses on processing waste materials into new products, thus conserving natural resources and reducing the demand for raw materials (Yuan, 2013b). Together, these practices help lower the carbon footprint of construction activities and contribute to a circular economy where resources are continuously reused (Umar et al., 2017).

Another critical aspect of construction waste management is compliance with environmental and safety regulations (Lu & Tam, 2013). Governments and regulatory bodies enforce standards to ensure waste is disposed of responsibly and does not pose risks to public health or ecosystems. For instance, hazardous waste such as asbestos, lead-based paint, or contaminated soil must be handled with specialized procedures to prevent environmental contamination. Adhering to these regulations not only safeguards the environment but also protects companies from legal liabilities and fines (Umar et al., 2017). Technology plays an increasingly important role in enhancing waste management practices (Yuan, 2013b). Innovations such as Building Information Modeling (BIM) allow for better planning and material estimation, reducing the likelihood of excess waste (Akinade et al., 2016). Advanced recycling technologies can process complex materials, turning what was once considered waste into valuable resources (Lu et al., 2017). Additionally, digital waste tracking systems help monitor and optimize waste streams, ensuring accountability and efficient resource recovery. These technological advancements pave the way for smarter and more sustainable construction practices (Yuan, 2012).

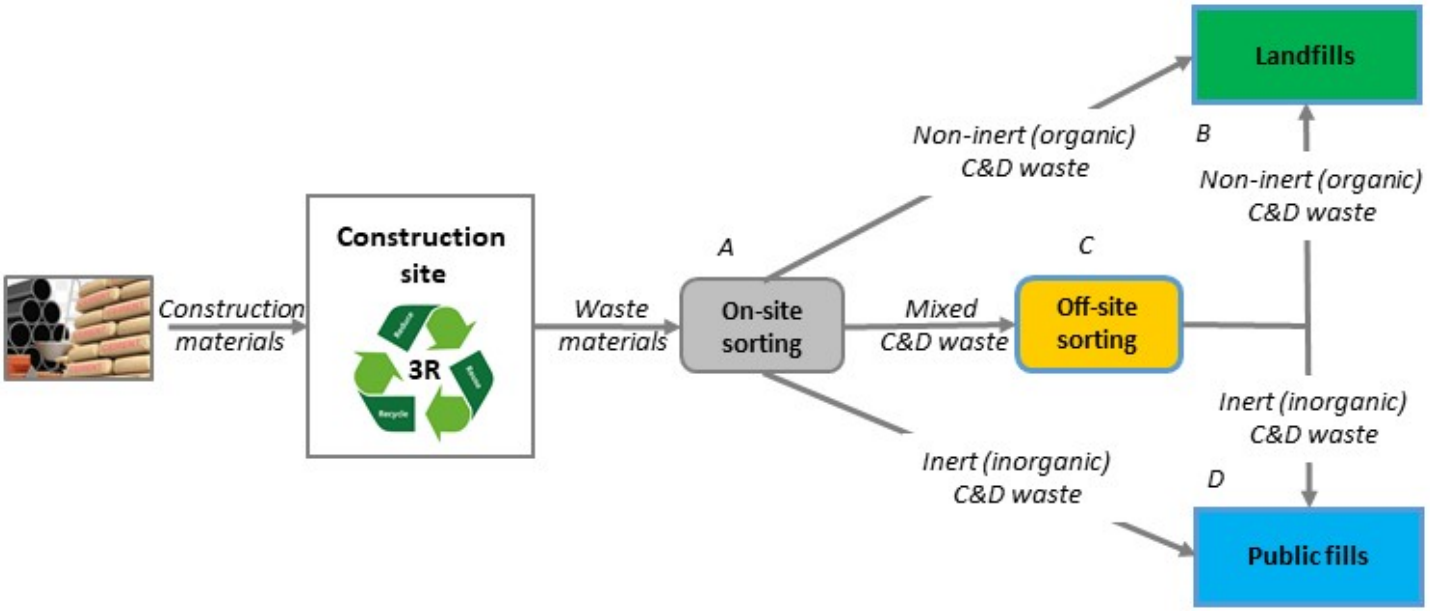

Fig. 1 A view of general construction waste management process (Lu et al., 2021)

Despite its importance, effective waste management faces challenges such as limited infrastructure, insufficient awareness, and economic constraints (Lu & Tam, 2013). In many regions, the lack of adequate recycling facilities and disposal sites hinders the implementation of sustainable practices (Newaz et al., 2022). Additionally, the construction industry's reliance on traditional methods and materials often overlooks the benefits of modern waste management strategies (Hao et al., 2022). Bridging this gap requires not only technological solutions but also education and cultural shifts to prioritize sustainability at every stage of construction (Spišáková et al., 2021). Effective waste management in construction ultimately depends on the collaborative efforts of stakeholders, including architects, engineers, contractors, policymakers, and the public. By fostering a shared commitment to sustainability and adopting best practices, the construction sector can significantly reduce its environmental impact while promoting economic growth (Lu et al., 2021). Long-term success lies in creating policies and incentives that encourage innovation and investment in waste management solutions, ensuring that construction activities align with the principles of environmental stewardship and sustainable development (Lu & Tam, 2013).

The construction industry is one of the largest contributors to global waste, generating significant amounts of debris that pose environmental, economic, and social challenges (Newaz et al., 2022). Developing suitable strategies for construction waste management is essential to address these challenges effectively (Lu et al., 2021). Without proper management, construction waste contributes to land degradation, pollution, and depletion of natural resources. By implementing well-planned strategies, the industry can minimize its environmental footprint, conserve valuable materials, and reduce the overall cost of construction activities (Udawatta et al., 2015). Incorporating suitable strategies promotes sustainability by aligning construction practices with environmental goals (Akinade et al., 2016). Sustainable construction waste management not only reduces the volume of waste sent to landfills but also encourages resource efficiency by reusing and recycling materials (Wong & Yip, 2004). This approach is crucial for mitigating the environmental impact of the construction sector, which consumes large quantities of raw materials and energy. By fostering a circular economy, suitable waste management strategies ensure that resources are reused instead of being discarded, contributing to long-term environmental stability (Ismam & Ismail, 2014).

Economic benefits are another compelling reason to provide effective strategies for waste management. Recycling and reusing materials can significantly reduce the cost of procuring new resources (Ouda et al., 2018). Additionally, adopting waste minimization strategies during the design and construction phases can save money by reducing material wastage (Li et al., 2015). Efficient waste management also decreases expenses associated with waste disposal and landfill use, creating cost-saving opportunities for construction companies (Schützenhofer et al., 2022). Social responsibility is also an important driver for implementing waste management strategies. Poorly managed construction waste can lead to public health issues, such as air and water pollution, and pose safety risks to workers and surrounding communities (Othman & Abdelrahim, 2020). By adopting sustainable strategies, construction firms can demonstrate their commitment to corporate social responsibility (CSR), enhancing their reputation and fostering trust among stakeholders (Ibrahim, 2016).

Modern waste management starts at the design phase. Using BIM and other design tools, architects and engineers can plan projects to optimize material use and minimize waste (Iodice et al., 2021). For instance, designing structures that use modular components reduces material offcuts and allows for easy disassembly and reuse (Han et al., 2021). Salvaging materials such as wood, metal, and bricks from construction and demolition activities is a key strategy. These materials can be reused in new projects, reducing the demand for virgin resources and minimizing waste. Establishing on-site sorting facilities helps streamline the recovery process (Lu et al., 2017).

Fig. 2 Waste management strategies for construction wastes (Ouda et al., 2018)

Advances in recycling technology enable the conversion of construction waste into new materials (Schützenhofer et al., 2022). Concrete, for example, can be crushed and reused as aggregate in road construction or new concrete mixtures. Similarly, asphalt, glass, and metals can be recycled efficiently, reducing landfill dependency (Lu & Tam, 2013). Implementing digital solutions, such as waste tracking systems, helps monitor and manage waste streams in real time. These systems improve transparency and accountability, allowing construction firms to identify inefficiencies and implement corrective measures promptly (Shen et al., 2004). The use of environmentally friendly materials, such as recycled aggregates, green concrete, and bio-based composites, contributes to sustainable waste management. These materials not only reduce waste but also enhance the sustainability profile of construction projects (Othman & Abdelrahim, 2020). Ensuring compliance with local and international waste management regulations is vital for sustainable construction (Umar et al., 2017). Governments and industry bodies can establish guidelines, incentives, and penalties to promote responsible waste management practices (Akinade et al., 2016). Sorting waste at the source improves recycling efficiency and reduces contamination of recyclable materials. Providing separate bins for different types of waste, such as wood, metal, and plastic, ensures proper segregation (Ismam & Ismail, 2014).

Collaboration between government bodies, private construction firms, and recycling organizations can enhance waste management infrastructure and services. Public-private partnerships can facilitate the establishment of recycling plants and disposal facilities, addressing gaps in waste management systems (Ibrahim, 2016). Educating construction workers about waste reduction, segregation, and recycling practices is crucial for effective waste management (Lu & Tam, 2013). Regular training programs and workshops can help instill a culture of sustainability across the workforce. Embracing the principles of a circular economy, where waste is viewed as a resource, can revolutionize construction waste management (Wahi et al., 2016). By designing processes that prioritize reuse and recycling, the construction industry can move towards zero-waste practices, achieving long-term sustainability.

II. Construction Waste Management in Iran

In Iran, the construction industry plays a pivotal role in national development, contributing substantially to urban expansion and economic growth. However, the sector's rapid growth has been accompanied by an alarming increase in construction waste generation (Ghoddousi et al., 2015). Despite various national initiatives aimed at waste reduction and recycling, the management of construction waste in Iran remains a persistent challenge, marked by inefficiencies in policy implementation, limited technological advancements, and socio-cultural barriers (Asgari et al., 2017). Addressing waste management challenges in the Iranian construction industry requires a comprehensive understanding of its unique characteristics, including material usage patterns, waste generation rates, and disposal practices. This paper explores the complexities of construction waste management in Iran, highlighting its multifaceted challenges. Furthermore, it investigates the socio-economic, regulatory, and cultural factors contributing to the inefficiencies in managing construction waste. By identifying key obstacles and potential strategies, this study aims to provide actionable insights to promote sustainable construction practices and foster the adoption of effective waste management systems in Iran.

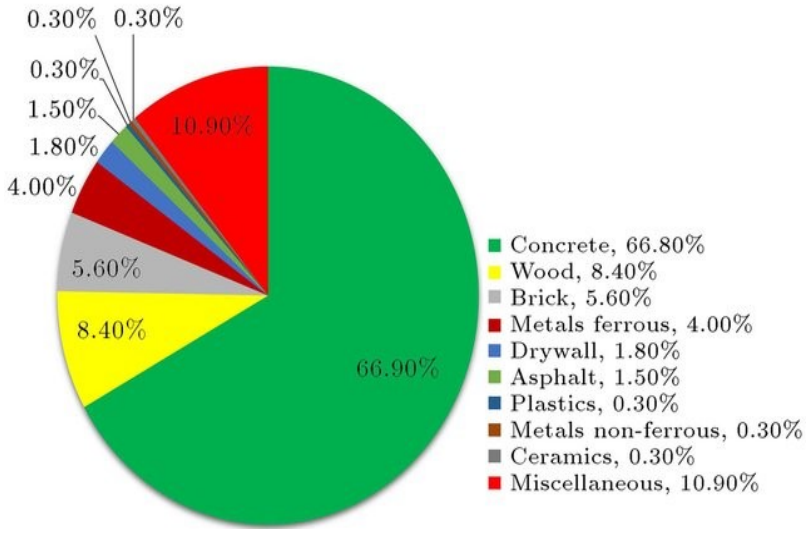

Fig. 3 A construction wastes variety in Iran (Mortaheb & Mahpour, 2016)

Construction waste management in Iran presents a unique set of challenges influenced by rapid urbanization, economic constraints, and socio-cultural practices. The construction industry, being a vital driver of the nation's development, generates significant waste, including concrete debris, metals, wood, plastics, and hazardous materials (Nikmehr et al., 2017). However, the country lacks a cohesive and efficient system to manage this waste, resulting in environmental degradation and missed opportunities for resource recovery (Moghadam et al., 2009). Addressing this issue requires a comprehensive understanding of the current state of construction waste management in Iran and the implementation of effective strategies tailored to its specific context (Najafpoor et al., 2014). One of the primary challenges in Iran is the absence of robust regulatory frameworks and enforcement mechanisms. Although there are laws governing waste management, their implementation is often inconsistent (Nikmehr et al., 2017). Construction companies frequently dispose of waste in unauthorized landfills or open spaces due to insufficient monitoring by authorities. This not only leads to land and water contamination but also exacerbates air pollution, as waste is often burned inappropriately to clear sites. Strengthening regulations and improving oversight are essential steps to curb these practices (Ghanbari, 2022).

Another significant issue is the lack of recycling infrastructure in Iran. While recycling construction waste is a standard practice in many developed countries, Iran struggles with limited facilities for sorting and processing construction debris (Moghadam et al., 2009). As a result, valuable materials such as metals, wood, and aggregates often end up in landfills instead of being recovered and reused. Establishing dedicated recycling plants and on-site sorting mechanisms could significantly improve resource recovery rates and reduce environmental impacts (Nazhand, 2016). Economic constraints further complicate construction waste management in Iran (Ansari & Ehrampoush, 2018). The high cost of advanced waste management technologies and the lack of financial incentives discourage companies from adopting sustainable practices (Nikmehr et al., 2017). Additionally, the informal nature of many small construction projects makes it difficult to implement standardized waste management protocols. Introducing government subsidies or tax incentives for companies that invest in sustainable waste management could help overcome these economic barriers (Ghanbari, 2022). Public awareness and cultural attitudes towards waste management also play a crucial role. In many cases, construction stakeholders, including contractors and workers, lack adequate knowledge about sustainable waste handling practices. This knowledge gap leads to improper waste segregation and disposal, undermining efforts to recycle or reuse materials. Educational campaigns and training programs tailored to the construction industry can help promote a culture of sustainability and encourage compliance with waste management best practices.

III. Conclusion

Effective construction waste management is critical for promoting sustainability, minimizing environmental degradation, and optimizing resource use in Iran's rapidly growing construction industry. Despite the significant challenges posed by weak regulatory enforcement, limited recycling infrastructure, economic constraints, and socio-cultural barriers, there are clear opportunities for improvement. Addressing these issues requires a multi-dimensional approach, including strengthening policies, establishing modern recycling facilities, and fostering awareness among industry stakeholders. Adopting advanced technologies such as BIM and encouraging public-private partnerships can further enhance waste management efficiency. Additionally, financial incentives and educational programs tailored to the construction sector can support the adoption of sustainable practices and create a culture of responsibility. By implementing these strategies, Iran can mitigate the adverse impacts of construction waste, conserve valuable resources, and support the country's broader goals of sustainable urban development. A concerted effort by policymakers, industry leaders, and the public will ensure a cleaner, greener future for Iran's construction sector and its environment.

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AUTHORS' CONTRIBUTIONS

Yashar Asefi and Karim Azizzadeh Gahreman conducted the main data analysis, contributed to the data collection, preprocessing, and interpretation, and were responsible for drafting the initial manuscript. Reza Javani performed checks, supervision, conceptual guidance, and critical revision of the manuscript. All authors read and approved the final manuscript.

CONFLICT OF INTEREST

The authors have not disclosed any competing interests.

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REFERENCES

Akinade O.O., Oyedele L.O., Munir K., Bilal M., Ajayi S.O., Owolabi H.A., Bello S.A. (2016). Evaluation criteria for construction waste management tools: towards a holistic BIM framework. *International Journal of Sustainable Building Technology and Urban Development*, 7(1), 3-21. https://doi.org/10.1080/2093761X.2016.1152203.

Ansari M., Ehrampoush M.H. (2018). Quantitative and qualitative analysis of construction and demolition waste in Yazd city, Iran. *Data in Brief*, 21, 2622-2626. https://doi.org/10.1016/j.dib.2018.10.141.

Asgari A., Ghorbanian T., Yousefi N., Dadashzadeh D., Khalili F., Bagheri A., Mahvi A.H. (2017). Quality and quantity of construction and demolition waste in Tehran. *Journal of Environmental Health Science and Engineering*, 15, 14. https://doi.org/10.1186/s40201-017-0276-0.

Ghanbari M. (2022). Dynamic analysis of construction and demolition waste management system (a case study of Tehran, Iran). *Advances in Civil Engineering*, 2022(1), 9348027. https://doi.org/10.1155/2022/9348027.

Ghoddousi P., Nikmehr B., Hosseini M.R., Chileshe N., Rameezdeen R. (2015). Barriers to construction and demolition waste management in developing countries: Case of Iran. In: *Proceedings of the Unmaking Waste 2015 Conference*, Adelaide, Australia.

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.

Hao J.L., Yu S., Tang X., Wu W. (2022). Determinants of workers' pro-environmental behaviour towards enhancing construction waste management: Contributing to China's circular economy. *Journal of Cleaner Production*, 369, 133265. https://doi.org/10.1016/j.jclepro.2022.133265.

Ibrahim M.I.M. (2016). Estimating the sustainability returns of recycling construction waste from building projects. *Sustainable Cities and Society*, 23, 78-93. https://doi.org/10.1016/j.scs.2016.03.005.

Iodice S., Garbarino E., Cerreta M., Tonini D. (2021). Sustainability assessment of Construction and Demolition Waste management applied to an Italian case. *Waste Management*, 128, 83-98. https://doi.org/10.1016/j.wasman.2021.04.031.

Ismam J.N., Ismail Z. (2014). Sustainable construction waste management strategic implementation model. *Wseas Transactions on Environment and Development*, 10, 48-59.

Kabirifar K., Mojtahedi M., Wang C., Tam V.W. (2020). Construction and demolition waste management contributing factors coupled with reduce, reuse, and recycle strategies for effective waste management: A review. *Journal of Cleaner Production*, 263, 121265. https://doi.org/10.1016/j.jclepro.2020.121265.

Li R.Y.M., Li R.Y.M., Du H. (2015). Sustainable construction waste management in Australia: a motivation perspective. *Construction Safety and Waste Management: An Economic Analysis*, pp. 1-30. https://doi.org/10.1007/978-3-319-12430-8_1.

Lu W., Tam V.W. (2013). Construction waste management policies and their effectiveness in Hong Kong: A longitudinal review. *Renewable and Sustainable Energy Reviews*, 23, 214-223. https://doi.org/10.1016/j.rser.2013.03.007.

Lu W., Webster C., Chen K., Zhang X., Chen X. (2017). Computational Building Information Modelling for construction waste management: Moving from rhetoric to reality. *Renewable and Sustainable Energy Reviews*, 68, 587-595. https://doi.org/10.1016/j.rser.2016.10.029.

Lu W., Yuan H. (2011). A framework for understanding waste management studies in construction. *Waste Management*, 31(6), 1252-1260. https://doi.org/10.1016/j.wasman.2011.01.018.

Lu W., Yuan L., Xue F. (2021). Investigating the bulk density of construction waste: A big data-driven approach. *Resources, Conservation & Recycling*, 169, 105480. https://doi.org/10.1016/j.resconrec.2021.105480.

Mills T.H., Showalter E., Jarman D. (1999). A cost-effective waste management plan. *Cost Engineering*, 41(3), 35.

Moghadam M.A., Mokhtarani N., Mokhtarani B. (2009). Municipal solid waste management in Rasht City, Iran. *Waste Management*, 29(1), 485-489.

Mortaheb M.M., Mahpour A. (2016). Integrated construction waste management, a holistic approach. *Scientia Iranica*, 23(5), 2044-2056. https://doi.org/10.24200/sci.2016.2269.

Najafpoor A.A., Zarei A., Jamali-Behnam F., Vahedian-Shahroudi M., Zarei A. (2014). A study identifying causes of construction waste production and applying safety management on construction site. *Iranian Journal of Health Sciences*, 2(3), 49-54.

Nazhand G. (2016). *A Financial Evaluation through Waste Management of Construction Projects Located in Iran*. Master Thesis, Eastern Mediterranean University (EMU), Famagusta, Cyprus.

Newaz M.T., Davis P., Sher W., Simon L. (2022). Factors affecting construction waste management streams in Australia. *International Journal of Construction Management*, 22(13), 2625-2633. https://doi.org/10.1080/15623599.2020.1815122.

Nikmehr B., Hosseini M.R., Rameezdeen R., Chileshe N., Ghoddousi P., Arashpour M. (2017). An integrated model for factors affecting construction and demolition waste management in Iran. *Engineering, Construction and Architectural Management*, 24(6), 1246-1268.

Othman A.A.E., Abdelrahim S.M. (2020). Achieving sustainability through reducing construction waste during the design process: A value management perspective. *Journal of Engineering, Design and Technology*, 18(2), 362-377. https://doi.org/10.1108/JEDT-03-2019-0064.

Ouda O.K.M., Peterson H.P., Rehan M., Sadef Y., Alghazo J.M., Nizami A.S. (2018). A case study of sustainable construction waste management in Saudi Arabia. *Waste and Biomass Valorization*, 9, 2541-2555. https://doi.org/10.1007/s12649-017-0174-9.

Schützenhofer S., Kovacic I., Rechberger H., Mack S. (2022). Improvement of environmental sustainability and circular economy through construction waste management for material reuse. *Sustainability*, 14(17), 11087. https://doi.org/10.3390/su141711087.

Shen L.Y., Tam V.W., Tam C.M., Drew D. (2004). Mapping approach for examining waste management on construction sites. *Journal of Construction Engineering and Management*, 130(4), 472-481. https://doi.org/10.1061/(ASCE)0733-9364(2004)130:4(47).

Spišáková M., Mésároš P., Mandičák T. (2021). Construction waste audit in the framework of sustainable waste management in construction projects—case study. *Buildings*, 11(2), 61. https://doi.org/10.3390/buildings11020061.

Udawatta N., Zuo J., Chiveralls K., Zillante G. (2015). Improving waste management in construction projects: An Australian study. *Resources,*

Conservation and Recycling, 101, 73-83. https://doi.org/10.1016/j.resconrec.2015.05.003.

Umar U. A., Shafiq N., Malakahmad A., Nuruddin M.F., Khamidi M.F. (2017). A review on adoption of novel techniques in construction waste management and policy. *Journal of Material Cycles and Waste Management*, 19, 1361-1373. https://doi.org/10.1007/s10163-016-0534-8.

Wahi N., Joseph C., Tawie R., Ikau R. (2016). Critical review on construction waste control practices: legislative and waste management perspective. *Procedia-Social and Behavioral Sciences*, 224, 276-283. https://doi.org/10.1016/j.sbspro.2016.05.460.

Wong E.O., Yip R.C. (2004). Promoting sustainable construction waste management in Hong Kong. *Construction Management and Economics*, 22(6), 563-566.

Yuan H. (2012). A model for evaluating the social performance of construction waste management. *Waste Management*, 32(6), 1218-1228. https://doi.org/10.1016/j.wasman.2012.01.028.

Yuan H. (2013a). A SWOT analysis of successful construction waste management. *Journal of Cleaner Production*, 39, 1-8. https://doi.org/10.1016/j.jclepro.2012.08.016.

Yuan H. (2013b). Key indicators for assessing the effectiveness of waste management in construction projects. *Ecological Indicators*, 24, 476-484. https://doi.org/10.1016/j.ecolind.2012.07.022.