INTERNATIONAL JOURNAL OF LATEST TECHNOLOGY IN ENGINEERING, MANAGEMENT & APPLIED SCIENCE (IJLTEMAS)

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue III, March 2025

A Model for Effective Application of Circular Economy Approach in Waste Management of Building Construction Sites in South East Nigeria

Itumo I.C., Okolie K.C. and Okoye N.M

Department of Building, Nnamdi Azikiwe University, Awka, Nigeria

DOI : https://doi.org/10.51583/IJLTEMAS.2025.140300014

Received: 01 March 2025; Accepted: 19 March 2025; Published: 02 April 2025

Abstract: The study presents a model for the effective application of the circular economy approach to waste management on building construction sites in Southeast Nigeria. Employing a qualitative research approach, data was gathered through structured, open-ended interviews conducted with 322 key stakeholders, including contractors, clients, and consultants proportionally distributed across Anambra, Enugu, Abia, Ebonyi, and Imo States. The stakeholders, drawn from a total population of 1,653 building construction professionals, were identified through purposive sampling. The study explored current waste management practices, the primary factors influencing waste generation and disposal, the extent of utilization of recycled materials by construction firms, and the challenges associated with applying circular economy principles. The findings revealed the prevalent use of traditional waste management practices, limited adoption of recycled materials, and significant barriers such as inadequate infrastructure, low stakeholder awareness, and resistance to change. The proposed model integrates circular economy principles to address these issues. Key components of the model include enhancing waste recycling initiatives, integrating waste management plans into project planning, mitigating root causes of waste through infrastructure investment and awareness campaigns, and promoting the reuse of construction and demolition waste as secondary raw materials. The model also emphasizes fostering stakeholder collaboration, developing sustainable urban strategies, and overcoming industry resistance to circular economy adoption. The research concludes by advocating for policy development, capacity building, infrastructure investment, and stakeholder engagement to facilitate the successful implementation of the model. Recommendations for future research and practical strategies for monitoring and evaluation of waste management initiatives are also provided, emphasizing the need for continuous innovation and collaboration in the construction sector. This study offers a significant step toward achieving sustainable waste management practices and advancing the principles of the circular economy within the Nigerian construction industry.

Keywords: Circular economy, Waste management, Construction waste, Construction and demolition waste

I. Introduction

Wastes are unwanted or unusable materials. Waste is any substance which is discarded after primary use, or it is worthless, defective and of no use. According to Thunberg, Rudberg, Karrbom (2017), the term waste is often subjective (because what is waste to one need not necessarily be waste to another) and sometimes objectively inaccurate (for example, to send scrap metals to a landfill is not proper because they are recyclable). Construction waste is a term commonly used when referring to waste resulting from the construction industry. Construction waste, according to Wuni and Shen (2022) is defined as "waste which are arising from construction, renovation, explosion activities, surplus and damaged products and material arising in the course of construction work and on-site work". It encompasses a wide variety of materials resulting from various activities including soil, rocks and vegetation from excavation, land leveling, civil works and site clearance (Greadel and Allenby, 2018). They also include roadwork materials (e.g., aggregates, pavement), worksite waste materials such as wood, plastic, paper, glass, metals, and demolition waste such as bricks, concrete, soil, gravel, gypsum, steel). Construction waste is due to excessively ordered supplies or mishandling of materials by unskilled laborers (Wuni and Shen, 2022)

Due to the significant role played by construction industry in developing and developed nation's growth, it has been criticized as unsustainable because it impacts negatively on the environment and makes onerous demands on natural resources (Osobajo 2020; Rose and Stegemann, 2018). Therefore, researchers, policy makers, governments and non-governmental organizations have recognized the need to promote sustainable construction. Nigeria, one of Africa's fastest-growing economies and the most populous, is endeavoring to implement sustainable practices. Its construction industry is viewed as lacking sustainable construction approaches towards waste management. The industry is heavily dependent on natural resources and its activities contribute to environmental degradation. A number of studies have identified high volumes of waste and this has highlighted the need for alternative approaches to the current traditional method of construction linked to the linear economy. Construction waste is generated throughout the construction process such as during site clearance, material use, material damage, material non-use, excess procurement and human error. According to Ramli and Aziz (2017), the largest contributor to the generation of construction waste is the building materials surplus. The short period of construction projects, normally 24 to 36 months with different stages of construction makes estimation of waste quite difficult and inaccurate (Pakir, 2019). According to Pakir (2019), the exact quantity and composition of construction waste generated throughout the projects are difficult to be identified and keep on changing due to the dynamic nature of construction activities.

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue III, March 2025

Circular economy (CE) is a sustainable development strategy that is being proposed to tackle urgent problems of environmental degradation and resource scarcity. Circular economy's 3R principles are to reduce, reuse and recycle materials. The principles account for a circular system where all materials are recycled, all energy is derived from renewable; activities support and rebuild the ecosystem and support human health and a healthy society and resources are used to generate value. The circular economy aims to foster an economy that retains as much of the value of materials as possible, for as long as possible (EEA, 2016). This means that the quantity of recycling or reuse is no longer the only objective: the type of recycling and the avoidance of down cycling is crucial. To transition to a circular economy, action that goes beyond waste management and improved recycling is necessary, as all products' lifecycle stages need to be involved. Utilization is the act or process of using a particular thing, idea or method to achieve a purpose (Dogo, 2018). Utilization of resources connotes the equitable use of resources of an enterprise. Construction waste utilization is a practice to recycle and reuse wastes for sustainable management of limited resources (Napier, 2016). Therefore, this study seeks to develop a model for the management and utilization of construction and demolition wastes in South East Nigeria with reference to the circular Economy perspective

II. Literature Review

Concept of Construction and Demolition Waste

Construction and demolition waste is a term commonly used when referring to waste resulting from the construction industry. Waste is unusable and unwanted material, and it is also called rubbish, trash, garbage (Kareem, 2015). Bakshan (2015), defined waste as "a material by-product of human or industrial activity that has no residual value." Waste is any material which is no longer used in a normal commercial cycle or chain of utility as the holder has a plan to throw away materials (Sertyesilisik, 2012), it encompasses a wide variety of materials resulting from various activities including soil, rocks and vegetation resulting from excavation, land leveling, civil works and site clearance. They also include roadwork materials (e.g., aggregates, pavement), worksite waste materials (e.g., wood, plastic, paper, glass, metals), and demolition waste (e.g., bricks, concrete, soil, gravel, gypsum, steel). This paper focuses on the latter; i.e., construction demolition waste (CDW), which usually constitute 20-30 times the quantity of waste generated from construction activities (Tunde, 2019). CDW has no single and agreed definition, and different countries perceive CDW in different ways. Kareem (2015) defined construction waste as follows: "Construction waste as the bye-products generated and removed from construction, renovation and demolition sites of building and civil engineering structures."

The disposal of construction waste has a negative impact on the environment as it has resulted in air pollution (CO_2 emission) water pollution, soil pollution, etc. (Wu, 2016; Ajayi, 2015 and Vivian., 2014). Construction Waste has also socio-economic impact. Udawatta (2015) argued that construction waste has not only economic impact but also it has negative environmental impact. Bakshan (2015) stated that construction and demolition waste has environmental impact and risks to human health. Construction waste can be described as the non-hazardous by-product resulting from activities during new construction and renovation. It is generated during the construction process because of factors such as site preparation, material use, material damage, material non-use, excess procurement and human error. Construction waste generation has become a major concern owing to it direct impacts on environment while affecting the efficiency of this industry (Ajayi, 2015). Building activity has huge environmental impacts from air pollution, noise pollution and water pollution. The most important and unpleasant environmental effect is from incineration which discharge pollutants to air (Lu and Yuan, 2011).

Construction waste issues have become more a part of the focus on a project due to cost and environmental awareness. In addition to its negative impact on the environment by generating waste, consuming landfills, and natural unrecoverable resources, construction project costs increase significantly due to the amount of waste. Environmental agencies have been assessing the waste produced from the construction industry. A report from the United States Environmental Protection Agency reports that 136 million tons of waste was generated in 2002. Construction waste generation has become a major concern owing to it direct impacts on environment while affecting the efficiency of this industry. Building activity has huge environmental impacts from air pollution, noise pollution and water pollution (Veleva, Bodkin, 2018). The most important and unpleasant environmental effect is from incineration which discharge pollutants to air. Contractors have to bear profit loss because of additional overhead costs and delays and loss of efficiency due to further time spend for cleaning (Wang and Hanzen, 2016). Construction waste is principally a mixture of surplus materials generated during new construction or a demolition waste. It can be a mixture of lot many materials or in some cases can be individual ones depending on the type of work. C&D waste could be formed due to excavation work, clearance of any project site, road works and renovation or demolition of structures etc. Masonry wastes can be easily mixed up with other wastes such as wood and drywall (Webster, 2015).

Overview of Circular Economy

Circular economy is an economic system that is based on business models which replace the "end-of-life" concept—a stage of any product that does not receive continuing support, either because existing processes are terminated or it is at the end of its useful life with reducing go alternatively reusing, recycling, and recovering materials in the production/distribution and consumption processes (Abila and Kantola, 2013). The concept of Circular economy implies a mindset change that considers waste as a potentially useful resource and not as a problem to manage and dispose. Circular economy is considered a solution as it would reduce environmental impact while contributing to economic growth. The concept circular economy has drawn

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue III, March 2025

considerable attention among researchers, institutions and policymakers. It is geared towards innovative and regenerative resource consumption, which is different from the usual linear model (Ezeudu and Ezeudu, 2019).

Circular economy contributes to raising productivity, optimizing the use of natural and human resources (Sehnem, 2019; Missemer, 2018) and increasing efficiency in resource management. CE proposes to replace wasteful and inefficient linear and open-ended cycles of production (input-output-waste) for a closed-loop where waste is minimized or transformed into inputs and value is created in the process (Sehnem, 2019; Homrich, 2018; Blomsma and Brennan, 2017). CE ideas have been gaining traction in the past decade in policy formulation, advocacy, consulting and natural sciences (Sehnem, 2019; Reikeet, 2018). The concept has been accepted by businesses across different sectors around the world as a solution to promote sustainability (Osobajoet, 2020; Ghiselliniet al., 2018; Lieder and Rashid, 2016; Preston, 2012) and the construction industry is not an exception

III. Methodology

This study utilized a qualitative research approach, employing interviews to gather data from building construction professionals actively involved in ongoing projects within Anambra, Enugu, Abia, Ebonyi, and Imo States. The target population included contractors, clients, and officials from building development control units within the states' Physical Planning Boards, all of whom were fully registered professionals. A preliminary survey revealed a total population of 1,653 key stakeholders comprising 333 clients, 894 contractors, and 426 consultants engaged in public projects. Using purposive sampling, a sample size of 322 participants was selected, which included 131 contractors, 40 clients, and 151 consultants proportionally distributed across the five states.

The interviews were conducted face-to-face with heads of departments, site managers, and other key stakeholders to gather detailed insights into their experiences and perspectives. A structured interview guide with open-ended questions ensured consistency while allowing for a conversational style that facilitated deeper exploration of relevant topics. This approach enabled the researcher to clarify responses and obtain rich, context-specific data aligned with the study's objectives. The interviews were designed to provide comprehensive information on the roles, challenges, and practices of construction professionals in the region.

IV. Results and Discussion

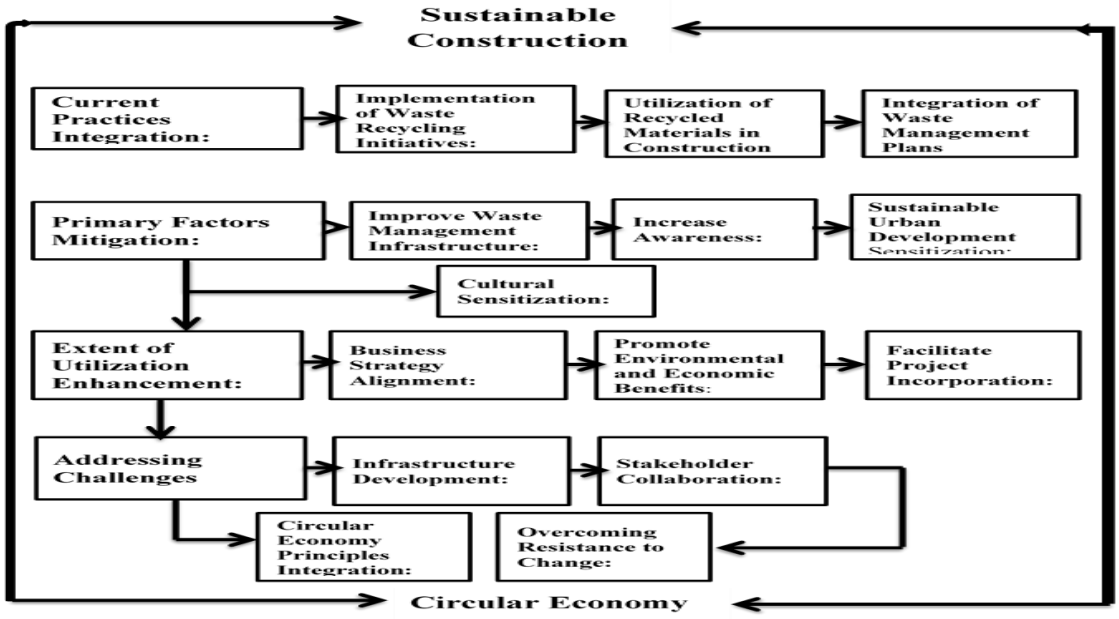

Figure: A Hypothetical Model for Effective Management of Wastes in South East Nigeria Using a Circular Economy Approach

Source: Adapted from Sharma, et al. (2021).

The proposed model for effective waste management in Southeast Nigeria, integrating the circular economy approach, addresses critical aspects including current practices, primary factors influencing waste generation and disposal, extent of utilization by construction firms, and challenges in applying circular economy principles. Drawing from existing research by Sharma, et al. (2021) on the circular economy approach in solid waste management and Wilson et al. (2015) on the global waste management outlook, this model aims to build upon previous findings and offer tailored solutions for the region.

Current Practices Integration: The model advocates for enhancing existing waste recycling initiatives, promoting the utilization of recycled materials in construction projects, and ensuring the integration of waste management plans into construction project planning processes. These practices align with the principles of circularity by emphasizing resource recovery, reuse, and responsible disposal.

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue III, March 2025

Primary Factors Mitigation: To address primary factors influencing waste generation and disposal, the model proposes investing in waste management infrastructure, increasing awareness among stakeholders, implementing sustainable urban development strategies, and conducting cultural sensitization campaigns. These efforts aim to mitigate the root causes of waste generation and promote sustainable waste management practices.

Extent of Utilization Enhancement: Encouraging construction firms to align waste utilization practices with their business strategies, highlighting the environmental and economic benefits of utilizing construction and demolition wastes, and facilitating the incorporation of recycled materials into projects are key components of this aspect of the model. By promoting the utilization of waste as secondary raw materials, construction firms can contribute to resource efficiency and sustainability.

Addressing Challenges: The model addresses challenges in applying circular economy principles by advocating for infrastructure development, fostering stakeholder collaboration, integrating circular economy principles into waste management practices, and overcoming resistance to change within the industry. These strategies aim to create an enabling environment for the adoption of circular economy practices and ensure the effective management of construction and demolition wastes.

Integration of Previous Research: The model draws upon previous research by Sharma et al. (2021) and Wilson et al. (2015) to inform its design and implementation. By incorporating insights from these studies, the model builds upon existing knowledge and leverages proven strategies to address waste management challenges in Southeast Nigeria. Thus, the proposed model offers a comprehensive framework for effective waste management in Southeast Nigeria, integrating the principles of the circular economy. By addressing current practices, primary factors influencing waste generation and disposal, extent of utilization by construction firms, and challenges in applying circular economy principles, the model aims to promote sustainability, reduce environmental impact, and optimize resource efficiency within the construction industry.

V. Conclusion and Recommendation

This study has provided valuable insights into the application of the circular economy approach in managing waste on building construction sites within Southeast Nigeria. By adopting a qualitative research approach, the study effectively gathered data from 322 key stakeholders, including contractors, clients, and consultants, across the five states of Anambra, Enugu, Abia, Ebonyi, and Imo. The findings highlight the roles, challenges, and practices of construction professionals in the region, emphasizing the critical need for effective waste management strategies that align with the principles of circularity. The proposed model addresses four key aspects of waste management: current practices, factors influencing waste generation and disposal, the extent of utilization by construction firms, and challenges in applying circular economy principles. It incorporates strategies to enhance recycling initiatives, promote the use of recycled materials, and integrate waste management plans into construction project planning processes. The model also identifies the root causes of waste generation and proposes solutions such as infrastructure investment, awareness campaigns, and sustainable urban development strategies.

Furthermore, the model aligns waste utilization practices with business strategies, highlights the benefits of using construction and demolition wastes, and fosters the incorporation of recycled materials into construction projects. It also tackles resistance to change by advocating for stakeholder collaboration, infrastructure development, and the integration of circular economy principles. The research draws upon previous studies by Sharma et al. (2021) and Wilson et al. (2015), ensuring the proposed model is evidence-based and tailored to the region's unique context. Through this model, this study contributes to the growing body of knowledge on sustainable waste management and offers practical solutions for optimizing resource efficiency, minimizing environmental impact, and promoting sustainability in the construction industry of Southeast Nigeria. The study recommends collaboration among stakeholders, including construction firms, regulatory bodies, and community members, should be fostered to promote shared responsibility and develop partnerships for waste management initiatives

References

1. Abila, B., & Kantola, J. (2013). Circular economy: Strategies for industrial waste management. Management of Environmental Quality: An International Journal, 24(4), 415–431. Retrieved from https://www.emerald.com/insight/content/doi/10.1108/14777831311322710/full/html
2. Ajayi, S. O. (2015). Design, procurement, and construction strategies for minimizing waste in construction projects. Construction Management and Economics, 33(1), 71–91. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/01446193.2015.1028955
3. Bakshan, A. (2015). Environmental impacts of construction and demolition waste. International Journal of Construction Management, 15(4), 246–253. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/15623599.2015.1086756
4. Blomsma, F., & Brennan, G. (2017). The emergence of circular economy: A new framing around sustainability challenges. Journal of Industrial Ecology, 21(3), 603–614. Retrieved from https://onlinelibrary.wiley.com/doi/full/10.1111/jiec.12603
5. Dogo, H. (2018). Resource utilization and construction waste management: A circular economy perspective. Environmental Economics and Policy Studies, 20(3), 475–488. Retrieved from https://link.springer.com/article/10.1007/s10018-017-0217-3

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue III, March 2025

6. Ezeudu, O. B., & Ezeudu, T. S. (2019). Implementation of circular economy principles in industrial waste management: Case studies and practices. Resources, Conservation and Recycling, 142, 249–261. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0921344919300968
7. Ghisellini, P., Cialani, C., & Ulgiati, S. (2018). A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems. Journal of Cleaner Production, 114, 11–32. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0959652615000512
8. Graedel, T. E., & Allenby, B. R. (2018). Industrial ecology and sustainable engineering (2nd ed.). Upper Saddle River, NJ: Pearson Education. Retrieved from https://www.pearson.com/store/p/industrial-ecology-and-sustainable-engineering/P100000094042
9. Homrich, A. S., Galvao, G., Abadia, L. G., & Carvalho, M. M. (2018). The circular economy umbrella: Trends and gaps on integrating pathways. Journal of Cleaner Production, 175, 525–543. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0959652617325218
10. Kareem, A. A. (2015). Construction and demolition waste: Current management practices. Journal of Environmental Research, 4(2), 17–23. Retrieved from https://www.researchgate.net/publication/276563456
11. Lieder, M., & Rashid, A. (2016). Towards circular economy implementation: A comprehensive review in context to manufacturing industry. Journal of Cleaner Production, 115, 36–51. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0959652615004212
12. Napier, T. R. (2016). Construction waste management: Strategies for sustainable practice. Building Research & Information, 45(4), 319–332. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/09613218.2016.1174245
13. Osobajo, O. A., et al. (2020). Advancing sustainable practices in the construction industry: A critical review. International Journal of Building Pathology and Adaptation, 38(4), 467–486. Retrieved from https://www.emerald.com/insight/content/doi/10.1108/IJBPA-06-2019-0049/full/html
14. Pakir, S. S. (2019). Challenges in construction waste estimation and measurement: A global perspective. Waste Management, 95, 237–248. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0956053X1930344X
15. Ramli, Z., & Aziz, A. (2017). Building materials surplus and construction waste: A critical analysis. Journal of Construction Engineering and Management, 143(8), 05017006. Retrieved from https://ascelibrary.org/doi/abs/10.1061/(ASCE)CO.1943-7862.0001346
16. Rose, C. M., & Stegemann, J. A. (2018). Circular economy in the built environment: Opportunities for waste reduction and reuse. Resources, Conservation and Recycling, 131, 172–186. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0921344917301942
17. Sertyesilisik, B. (2012). Construction waste management practices and their impact on sustainability. Sustainable Cities and Society, 5, 1–7. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S221067071100041X
18. Sehnem, S., Vazquez-Brust, D., Pereira, S. C. F., & Campos, L. M. S. (2019). Circular economy: Benefits and barriers in the context of industry 4.0. Resources, Conservation and Recycling, 140, 315–327. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0921344919300217
19. Thunberg, M., Rudberg, M., & Karrbom, G. (2017). Construction logistics in the circular economy. Journal of Cleaner Production, 164, 841–850. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0959652617301767
20. Tunde, A. M. (2019). Construction and demolition waste: Issues and challenges. Journal of Environmental Engineering and Science, 14(1), 45–53. Retrieved from https://www.nrcresearchpress.com/doi/abs/10.1139/jees-2018-0029
21. Vivian, R. J., et al. (2014). The environmental impact of construction waste. Journal of Environmental Management, 135, 67–73. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0301479713002335
22. Wang, C., & Hanzen, Z. (2016). Cost implications of construction waste management strategies. Construction Economics and Building, 16(1), 27–39. Retrieved from https://epress.lib.uts.edu.au/journals/index.php/AJCEB/article/view/4263
23. Webster, M. D. (2015). Masonry waste management in construction and demolition processes. Waste Management Research, 33(7), 567–574. Retrieved from https://journals.sagepub.com/doi/full/10.1177/0734242X15589134
24. Wu, H. (2016). Environmental impact of construction waste on urban ecosystems. Urban Ecology, 22(3), 233–249. Retrieved from https://www.springer.com/gp/book/9783319318720
25. Wuni, I. Y., & Shen, G. Q. (2022). Construction and demolition waste: A critical analysis. Waste Management & Research, 40(2), 109–125. Retrieved from https://journals.sagepub.com/doi/abs/10.1177/0734242X211030435