International Research Journal of
SCIENCE, TECHNOLOGY, EDUCATION, AND MANAGEMENT
P-ISSN: 2799-063X — E-ISSN: 2799-0648
Volume 4, No. 1 | March 2024

Exploring practitioners' knowledge of circular economy in the Ghanaian construction industry

Emmanuel Asiedu[1], Andrew Victor K. Blay Jnr[2], Senyo Kwame Denutsui[3]
[1]*Department of Building Technology, Takoradi Technical University, Takoradi, Ghana*
[2]*School of Architecture, Computing and Engineering, University of East London, England*
[3]*Department of Estate Management, Takoradi Technical University, Takoradi, Ghana*
Corresponding Author: emmanuel.asiedu@ttu.edu.gh

ABSTRACT

The circular economy model is gaining traction in a multitude of sectors, including construction. Incorporating this model into construction operations is anticipated to promote environmental sustainability while improving the industry's notorious reputation. This study investigates the knowledge level and comprehension of circular economy among 13 experienced professionals in the construction industry in Ghana. The research employed a qualitative methodology and used a semi-structured interview schedule to gather data. Participants' responses were analyzed using a thematic approach. Seven themes were established after participants shared their opinions. The themes included reuse and recycling, waste minimization, resource management, environmental approach, passive design concepts, sustainable/eco-friendly material selection, and collaborating/partnering, with reuse and recycling being the dominant theme. The study's findings indicate that construction practitioners were primarily concerned with reuse and recycling, with little awareness of circular economy applications. The limited knowledge and huge comprehension gap surrounding the theory and practice of circular economy must be addressed if construction professionals want a sustainable environment.

ARTICLE INFO

Received : Jan. 30, 2024
Revised : Mar. 2, 2024
Accepted : Mar. 31, 2024

KEYWORDS

Circularity, Circular economy, Construction practitioners, Themes

Suggested Citation (APA Style 7th Edition):

Asiedu, E., Blay Jnr, A.V.K., & Denutsui, S.K. (2024). Exploring practitioners' knowledge of circular economy in the Ghanaian construction industry. *International Research Journal of Science, Technology, Education, and Management*, 4(1), 9-21. https://doi.org/10.5281/zenodo.10971999

INTRODUCTION

Like most developing economies, Ghana's construction industry is under tremendous pressure to fulfil its core responsibility of supplying sufficient infrastructure. As stakeholders seek to attain this goal, they are challenged by the present threat posed by construction's consequences on the environment (Asante et al., 2022). Although numerous sustainable concepts and practices have been postulated by researchers (Mensah, 2019; Oke et al., 2019; Ives et al., 2018), the circular economy (CE) model provides a concentrated approach to environmental sustainability and industrial advancement. Circular Economy, also known as circularity, is an economic paradigm that upholds the value of products, materials, and resources within the economy for an extended duration while simultaneously reducing the production of waste (Webster, 2017). Ellen McArthur Foundation (2023), on the other hand, referred to the circular economy as a system purposefully created to restore or regenerate resources to lower pollution by utilizing improved materials, processes, and ultimately, operations. The adoption of a circular economy in construction business operations is expected to ensure environmental sustainability even though there can be significant challenges.

Agyekum and Amudjie (2023) postulated that a major challenge associated with the embrace of circular economy in the construction sector has been its lack of awareness and comprehension. Although circularity in construction is in its infancy stage (Adams et al., 2017), this can hamper its integration into construction operations. It is obvious that for new concepts and practices to thrive in any given field, they need the efforts of well-informed professionals and experts in the field to ensure their successful implementation.

Though existing studies (Yu et al., 2022; Eberhardt et al., 2020) have revealed enormous benefits of the circular economy, not much study has been carried out on the knowledge level of stakeholders in the Ghanaian construction sector. This lack of research and application of circular economy ideas by construction practitioners reveals a gap in their comprehension and execution. This research explores construction practitioners' knowledge and understanding of the concept of circularity in Ghana.

LITERATURE REVIEW

Overview of Activities in the Construction Sector

It is widely known that the construction sector extracts and utilizes massive amounts of natural resources (Najjar et al., 2019). Most of these resources later compound into an ever-growing extraction of non-renewable components during the conversion process. Generally, energy-intensive, the conversion process releases substantial greenhouse gases aside from other environmental damages like deforestation, desertification, acidification, and other forms of pollution. On a global scale, 39% of carbon emissions are attributed to construction-related activities, with landfills receiving approximately 40% of waste from buildings and demolished structures, while raw-material processing for buildings and infrastructure accounts for about 30% of total construction emissions per year, with building operations contributing to the remaining 70% (Kabirifar et al., 2020).

Based on the above statistics, the United Nations Environment Programme (UNEP) emphasized the need for better building thermal efficiency, reduced ecological impact of materials, and heightened funding for projects aimed at decarbonizing the building sector by 2050 (Mandel et al., 2023). If the current pattern of operations in the industry is not revised, our goal of achieving a sustainable environment cannot be realized. This situation makes it imperative for us to embrace sustainable concepts such as circular economy to avert unprecedented impacts.

Making a Case for Circular Economy

The linear economic model of production has dominated our culture since the Industrial Revolution. This model is notably characterized by the "take-make-dispose" approach, where raw materials are gathered, utilized for producing goods, and afterwards thrown away after their useful life (Avitesh, 2022). This model assumes unlimited

resources and has subsequently resulted in a massive transformation of economies and infrastructure as we have today. Ellen McArthur Foundation (2023) explained that the linear model ensured that goods were mass-produced, as if energy along with natural resources remained practically limitless. It is important to indicate that in this economic revolution, countless individuals have been lifted from impoverished circumstances while industrialized nations developed into affluent civilizations, amidst an increase in worldwide living standards. Notwithstanding the benefits, the linear economic model resulted in significant increases in the utilization of natural resources and the production of waste, including environmental degradation. As a result, this linear economic model can be labelled as unsustainable, contributing to pollution, climate change, and the depletion of precious resources. As a result of these repercussions, this industrial model is under increasing pressure to pave the way for the introduction of a sustainable and circular economy paradigm.

Unlike the linear economic theory, the circular economy presents an alternative paradigm that minimizes waste and pollution, conserves natural resources, and promotes the continuous use of resources. Awan et al. (2019) explained that the circular economy integrates economic production while considering environmental factors and providing an innovative approach toward resource use, while others also indicated that it ensures the implementation of a circular flow of materials in an economic environment (Yi et al., 2008). This sustainability concept is to enable the construction sector to abandon the conventional operating model that depends on the ideas of "take, make, and dispose" principles. A circular economy model, according to Awan et al. (2019) reduces resources used and the production of waste, pollution, and carbon emissions by producing a closed-loop structure through strategies like reuse, sharing, repair, refurbishing, remanufacturing, and recycling. In this instance, when construction materials reach their milestones, the components and pieces are reused and deconstructed into material banks for use in future structures, allowing them to maintain a closed cycle with materials and components. This ensures that products' worth and resources are preserved through eco-efficiency and sustainable resource management.

The interdependency network between the construction sector and circular economy is becoming more apparent (Górecki et al., 2019), as it bears revolutionary potential for sustainable development on numerous fronts. Its incorporation into the building process has the potential to significantly lower the industry's environmental imprint, particularly in terms of resource consumption and waste output.

As one of the largest waste producers, the construction sector may transform from a resource consumer to a resource provider by diverting construction waste from landfills and lowering the need for virgin materials through urban mining. This provides the door for the development of novel ways to handle waste from construction.

However, the benefits of a circular economy in the construction sector extend far beyond environmental considerations. The economic implications are broad and diverse, ranging from encouraging economic growth by offering market opportunities for recycled and renewable materials to creating new job opportunities in fields such as recycling, refurbishing, and green design. The shift to a circular construction sector can help diversify the economy and create a more robust sector that is less sensitive to resource inflationary pressures and supply chain constraints.

OBJECTIVES OF THE STUDY

The study explores practitioners' knowledge and understanding of circular economy in the Ghanaian construction sector. The objectives include: a) investigating the awareness level and the extent to which circularity is incorporated into construction operations; b) identifying the benefits practitioners have accrued after incorporating circular economy principles into their construction operations.

RESEARCH METHODOLOGY

Research Design

This study used the qualitative research design to comprehend the subjective experiences of participants on how they incorporated circular economy into their operations. Using an inductive approach, a thematic analysis was used as described by Braun and Clarke (2012).

Instrument

Participants were interviewed using a structured instrument that was pretested and adapted. This form of interview, which was mainly done face-to-face, had a predetermined number of questions that were deemed appropriate for sensitive topics or topics that needed in-depth exploration (Braun & Clarke, 2012). After reviewing and analyzing existing literature, a topic guide was developed to guide the interview.

Participants

Participants were practitioners currently taking part in the planning/design, execution, and post-construction phases of the construction process. These participants had ample years of work experience and had played vast roles in the construction sector in Ghana. They were recruited using both recommendations alongside emails and phone calls. Following the argument submitted by Dworkin (2012), a preliminary screening comprising established construction practitioners was assembled. Participants were invited to reply to a brief survey (via Survey Monkey) verifying their location, expertise, and readiness for a discussion. Thirteen participants finally consented to take part in the study. These participants were practising construction full-time, had the necessary professional certifications, and were prepared to devote enough time to the study.

A schedule was then agreed upon for the interview to be carried out, utilizing open-ended questioning with participants. The majority of the interviews were conducted in person. Each interview lasted between 45 - 75 minutes. It was conducted interactively and openly to obtain a deeper exploration (Rubin & Rubin, 2012; Kvale & Brinkmann, 2009). Both audio recording and note-taking were employed during the data collection phase with approval from the participants.

Ethical considerations

Participants' confidentiality and anonymity were guaranteed by using acronyms and sequential cardinal numerals in the findings.

Conducting the Analysis

The recorded interviews and notes were transcribed verbatim to enable thematic analysis. The team reexamined the transcripts after verifying their veracity several times compared to the initial recordings. In this study, the QDA Miner v6 software was used for the interpretation of data. The data analysis procedure was guided by the six-stage data collection and analysis approach proposed by Peel (2020). They include (a) Data collection; (b) Interaction with the data (c) Codifying what is extracted from the data; (d) Creating codes using the categorized coded extracts; (e) Conceptualizing the themes from the categorized coded extracts; alongside (f) Contextualizing and representing the findings.

Data-driven coding and analysis (Frith & Gleeson, 2004) were employed to produce the themes through an inductive evaluation of the data. This followed Peel's procedures to first identify, characterize, and analyze themes at a semantic level prior to delving further into their repercussions, importance, and interpretations (Braun & Clarke, 2012).

Notes gathered during each interview were appended to the right column of the transcripts. After that, the codes were put together in a different Word document and subjected to analysis and classification. The categorized items were assessed and contrasted with the original transcripts. Throughout this procedure, 137 original codes and 52 categories were adopted. Themes were consciously created afterwards.

Finally, all similarities and overlaps were examined by analyzing the main core of these themes, allowing them to be reduced to a few themes that best reflected the data and fulfilled the study's goal.

FINDINGS AND DISCUSSIONS

Sample Characteristics

The 13 participants who voluntarily participated in the interview were aged between 30 and 60 years with diverse years of experience. Interviews with participants took place in person. The characteristics of the participants have been outlined in Table 1. Participants were currently involved with construction work, and due to the mode of recruitment, it was evident that they operated throughout the various phases of the construction process.

Table 1. Participants Details

Interviewee	Gender	Age (Years)	Highest Education Level	Role	Years of Experience	Knowledge of Circular Economy
Engr. 1	Female	38	Master's degree	Materials engineer	14	Unlimited
CM 1	Male	39	Master's degree	Construction manager	12	Unlimited
ART	Male	41	Master's degree	Architect	11	Unlimited
CM 2	Male	45	Bachelor's degree	Planner/QS	20	Limited
Engr. 2	Male	39	Bachelor's degree	Site Manager	11	Limited
CM 3	Male	37	Bachelor's degree	Construction manager	9	Unlimited
PM 1	Male	43	Bachelor's degree	Project manager	12	Limited
PM 2	Male	46	Master's degree	Project manager	17	Unlimited
CM 4	Male	51	Bachelor's degree	Engineer	21	Limited
CT 1	Female	39	Bachelor's degree	Construction manager	18	Limited
Engr. 3	Male	42	Bachelor's degree	Site Manager	14	Limited
Engr. 4	Male	35	Bachelor's degree	Site Manager	8	Limited
ED-CD	Male	40	Bachelor's degree	CE Consultant	7	Unlimited

Participants' knowledge and understanding of Circular Economy

Participants had significant years of work experience in the construction sector. The background checks also revealed diverse roles played by participants, ranging from design and construction to post-construction activities. The interview questions sought to explore practitioners' knowledge and comprehension of circularity, how they adapt it, and the benefits they have attained after adopting it.

The concept of circular economy was unfamiliar to most participants, as they often requested further explanation. Circular economy and sustainability-related concepts have always been regarded as thorny issues among practitioners in various sectors (Akotia et al., 2016). Aside from being regarded as novel, its application is plagued with complications, leading to its minimal adoption and implementation.

Few participants *(n = 5)* were able to adequately expatiate the concept of circular economy. A participant (tagged as PM 2) who is a project manager and has been in the construction sector for 17 years described the circular economy in the interview as;

> "A cyclical framework that includes production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing, and recycling existing materials and products as long as possible".

On the other hand, a participant (tagged as Engr. 1) who is a material engineer with 14 years of work experience also described circular economy as;

"A production model which involves recycling, refurbishing and reusing existing products for consumption".

Another participant who is an architect (tagged as ART) with over a decade of work experience described circular economy as;

"A cycle in which construction materials and site resources are effectively managed and redesigned for use in the form of planning and recycling with the main objective to reduce waste materials cut down construction costs and extend the life span of structures".

A construction manager (tagged as CM 3) with 9 years of work experience who supervises site operations also considered circular economy as;

"An economic and environmental approach that seeks to minimize waste and maximize the sustainable use of resources".

These definitions were consistent with circular economy definitions outlined in several studies (Repp et al., 2021; Kirchherr et al., 2017; Sauvé et al., 2016). They unanimously emphasized terminologies such as reuse and recycling, waste minimization, transforming of waste, eco-efficiency and resource productivity, resources regeneration/restoration and sustainability development.

Analysis of responses from participants revealed 7 key themes comprising of the following: (a) reuse and recycling, (b) waste minimization, (c) resource management, (d) environmental approach, (e) Passive design concepts, (f) Sustainable/ Ecofriendly materials selection, and (g) Collaborating/Partnering. These themes were identified after coding, categorization and aligning them into themes. The descriptions of these themes have been derived using quotes from the participants.

Reuse and Recycling

Most of the participants interviewed considered the circular economy as a concept that focuses on reuse and recycling. The ''Reuse and Recycling" theme constituted 45% of the codes. This theme was depicted in a comment by a participant (tagged as Engr. 4) who is a Civil engineer with 8 years of work experience, to him.

"Circular economy refers to the reuse of materials to reduce waste, and carbon emissions and create new products from the waste".

Another participant who is a top construction manager (tagged as CM 1) with 12 years of work experience described circular economy as;

"A method of recycling one or two materials to reduce waste or minimize cost in the system".

The Architect (ART) mainly engaged with the designing of residential and commercial buildings for both public and private clients over a decade referred to circular economy as;

"A cycle in which construction materials and site resources are effectively managed and redesigned for use in the form of planning and recycling with the main objective to reduce waste materials cut down construction cost and extend the life span of structures".

Participants also provided examples of how this concept is demonstrated. A representative example was provided by a site supervisor (tagged as CT 1) with 18 years of work experience in a Real Estate business. He explained that;

"They reutilize roofing sheets obtained from the demolition of buildings for hoarding activities and to serve as hoarding and formworks to columns etc., leasing and repair".

Another participant who is a seasoned construction manager (tagged as CM 2) with a decade of work experience further indicated that to enhance reuse;

"They make sure plywood with polythene to prevent staining of the concrete grout to allow for reuse".

Four of the participants (tagged as Engr. 1, CM 1, CM 2, and CM 3) stated that they employ the recycling concept in their operations which they accomplish by extracting new materials from discarded items. CM 1 explicitly said that;

"In their organization, they utilize blocks moulded by using plastics as a binder and use broken concrete as hard-core filling materials".

Waste minimization

The next most dominant theme found was waste minimization with 19.6% of the codes. Some participants described circular economy as a waste minimization initiative. A participant who is an engineer (tagged as Engr. 2) with 11 years of work experience in the design and construction of civil infrastructure defined circular economy as;

"A waste minimization initiative which intends to reuse and recycle materials for other purposes".

A participant (tagged as ED-CE) who is a construction project consultant and an advocate for circular economy described CE as;

"A process which is aimed at reducing waste through recycling wastes, redesigning items to reduce wastes and reuse items".

Another participant (tagged as Engr. 3) who is an engineer with a specialization in structural design for 14 years said that;

"Circular economy is about ensuring that you extract the maximum amount of usefulness from materials before you dispose of them to reduce the wastage in the construction environment".

Engr. 3 further explained by saying that;

"We design buildings in a way that we will have less wastage of materials and also most of the materials are reused again".

A participant who has been a project lead (manager) (PM 2) for 7 years said that;

"They implement practices that will minimize material waste".

Efficient Resource Management

Other participants also viewed circular economy as a strategy that can be used to manage resources efficiently. One interviewee, who was a construction manager (CM 2) with 20 years of work experience in Project

Planning and Quantities described circular economy as;

"A strategy for maximizing the use of materials to make profits and also ensure environmental friendliness".

This description was buttressed by a participant who is a District engineer (CM 4) with 21 years of work experience in a District and Metropolitan Assembly, who elucidated that;

"Circular economy is a way of maximizing the lateral resources available to achieve project quality and meeting time and cost target".

Environmental Approach

Other participants considered circular economy as an environmental approach as depicted in the description given by a participant who was a project manager (PM 1) for 12 years. PM 1 described circular economy as;

"The sustainable use and reuse of resources".

Another participant (CM 3) who has been involved in project supervision for 9 years narrated that circular economy is;

"An environmental approach that seeks to minimize waste and maximize the sustainable use of resources".

Passive Design Concepts

To demonstrate their knowledge of circular economy, some of the individuals interviewed said they inculcated circular economy principles in their operations through the utilization of passive design concepts. For instance, ART who is an architect explained by saying;

"During the design stage, the project team carefully surveyed and identified site resources using complex 3-D imagery devices to preserve site resources and cut down costs during construction".

CM 3 also reported that circular economy principles are inculcated into their operation by;

"Advocating for designs that promote resource efficiency".

Collaborating/ Partnering

Participant CM 3 who has been involved in project supervision for 9 years further stated that;

"Circular economy enables collaborating with construction partners to reduce waste and encourage recycling and reuse".

Participant ED-CE also indicated that through partnership;

"… we help other organizations to inculcate CE principles from construction, fashion, green mobility, and textile materials engineering."

Sustainable/Eco-friendly materials selection

Participant CM 3 narrated that their preference for sustainable materials indicates that they adopt circular economy principles. He indicated that;

"They frequently recommend sustainable building materials and some aspects of Circular Economy that can be applied include sustainable design and its materials selection".

Participants' views on benefits accrued after incorporating Circular Economy

Participants shared the benefits accrued after incorporating circular economy principles into operations. The benefits identified were categorized into themes in the analysis. Five themes were identified comprising; (a) Value for money, (b) Environmental sustainability, (c) Waste reduction, (d) Enhanced Reputation and competitive advantage, and (e) Improved materials quality.

Value for Money

Participants' responses revealed a strong theme of value for money. There is a significant concern for the project to be completed within the agreed time, budget (cost) and scope (quality) as they directly influence construction project success. Respondents explained that with the introduction of a circular economy, they have

been able to achieve value for money. In total, 9 participants made use of this theme which was developed when respondents made use of cost reduction, cost savings, and reduction in time (duration) only to mention a few. A participant (tagged as ART) commented by saying that there was a decline in.

" …. excess cost which could arise during the construction stage".

Another participant (CT 1) said this after adopting some circular economy principles.

"…… it reduces time wastage in obtaining invoices".

Environmental sustainability

Environmental sustainability was another theme that manifested in some participants' responses. Six participants indicated that inculcating circular economy principles into their operations led to environmental sustainability. This was indicated in participant CM 3 response. CM 3 indicated that;

"Circular economy also reduces the carbon emission in the environment".

CM 4 on the other hand stressed this theme by making two statements. He explained that by inculcating circular economy principles into their operations;

"Natural environment is protected "and "Maximization of limited natural resources".

Another participant (ED-CE) also had this to say about environmental sustainability due to the incorporation of circular economy principles. He commented that it;

"… contribute to broader sustainability goals, such as reducing carbon emissions".

Waste reduction

For some participants, waste reduction dominated the discussions on the benefits of CE application in construction. For instance, participant CM 4 narrated that by incorporating circular economy principles, there have been;

"…. waste minimization in their construction".

Participant CM 2 also said that;

"Circular economy applications largely reduce construction wastes".

Enhanced reputation and competitive advantage

In a world where environmental sustainability is gradually being prioritized, participants indicated when circular economy principles are incorporated into construction operations contractors/professionals gain a reputation and competitive advantage among their colleagues. CM 3 explained further when he responded to the benefits associated with circular economy principles inclusion into their construction operations. He said;

"Incorporating Circular Economy principles into construction is pivotal not only for environmental sustainability but also for maintaining competitiveness in an industry increasingly focused on eco-friendly practices. Competitive advantage in a market increasingly valuing environmental responsibility".

Improved materials quality

Participants reiterated that circular economy applications lead to improvement in the quality of the materials. A participant (tagged as CM 1) indicated that using circular economy principles, the finish materials appeared improved but fell short of indicating or describing specific materials they used. CM 1 reported that;

"It gives you durability in the materials which reduces maintenance and gives you the best finishing".

Discussions

This study explored construction practitioners' knowledge and comprehension of circular economy and its principles in the Ghanaian construction sector. Participants provided information on how they apply it to their operations, throwing more light on their level of knowledge and comprehension of the idea.

Participants' perspectives on circular economy were closely tied to the roles they play or areas of specialization. In other words, their fields of specialization had an imprint on their perception of circular economy. Findings from the study showed that the majority of the practitioners were unfamiliar with the principles of circular economy and how to adequately incorporate them coherently into their construction operations. Despite showing glimpses of circular economy ideas, participants' comments revealed a lack of in-depth knowledge and comprehension of their practical applications. This is not uncommon as a plethora of studies (Adams et al., 2017; Agyekum & Amudjie, 2023) have underscored knowledge gaps and an unlimited understanding of constructs used in circular economy. Morseletto (2020) further opined that since circular economy is in its infancy stage of being introduced into construction operations, it may be subject to many interpretations.

Participants' explanations of circular economy in the study varied from it being considered as a “production process”, “method of reuse and recycling”, “production model”, and “as a cycle for effective resource management” just to mention a few. These constructs were slightly linked to how some scholars described circular economy which includes a business model (Manninen et al., 2018) or as a restorative and regenerative system (Eberhardt et al., 2020) or as an implementation technique (Reike et al., 2018; Lieder & Rashid, 2016).

From the study, some participants considered circular economy as a waste-reduction strategy. This limits the potential of the concept that ensures materials are kept in a close loop in the supply chain even when an item's lifespan is about to expire (Norouzi et al., 2021). Morseletto (2020) explained that it consists of interrelated constructs broadly presented as R-strategies, which depict the different stages of resource use and waste management with each contributing to how we can create, preserve, and recover the value of inputs in inspiring ways.

Participants indicated the phases of the construction process at which they incorporated circular economy into their operations. While some indicated that they inculcated it at the project initiation stage, other participants hinted that it was done at the construction stage of the project process. Other participants opined that circular economy principles are inculcated in both phases of a construction process. Többen and Opdenakker (2022) provided a framework that was aimed at including circularity at the onset of construction infrastructure projects. It emerged that early incorporation of circularity results in the consideration of all project practitioners' views, which ensures proper cohesion of activities and the attainment of goals.

The benefits of adopting circularity into construction operations identified from the participants' responses were formulated as themes that consisted of value for money, environmental sustainability, waste reduction, enhanced reputation and competitive advantage, and improved material quality. They were consistent with earlier studies that reported that circularity can reduce both the sourcing of raw materials and waste sent to landfills (Norouzi et al., 2021).

These benefits were also akin to the pillars of sustainability, whose key benefits include environmental benefits, societal benefits, and economic benefits. Among the themes classified under environmental benefits were “environmental sustainability” and “waste reduction” since they have direct impacts on the environment. The theme “enhanced reputation and competitive advantage” was seen as having a societal benefit as construction practitioners gain reputation from their compatriots since they can ensure circularity in their operations. The economic benefits of applying circularity from participants' views are also comprised of themes such as “value for money” and “improved material quality” thereby ensuring profitability after its adoption. This epitomizes the connectivity between circular economy and sustainability.

IMPLICATIONS OF THE STUDY AND RECOMMENDATIONS

In the study, the majority of participants were unfamiliar with circular economy principles and their application in construction. Their remarks revealed inadequate knowledge and understanding of the practical construction application of circular economy. This translated into its limited application. It was obvious that practitioners mainly relied on the reuse and recycling concepts of circular economy during construction. This proves the extensive knowledge gap that persists and needs to be addressed if indeed construction professionals wish to ensure environmental sustainability. Due to its limited application, practitioners were not witnessing its substantial benefits.

The study's results, alongside findings from existing literature, provide enough background for further research and advocacy on the tenet of circular economy and how this concept can be embedded into construction operations in our quest to ensure environmental sustainability. Circular economy application is gradually gaining acceptance in the construction sector. Positive implications for both academia and industry are revealed in this study as we become aware of the shortcomings faced by construction practitioners concerning circularity.

From the findings of the study, some recommendations were made. First, it has become imperative for the talk about circular economy to be enhanced among construction practitioners to raise awareness. It is therefore recommended that practitioners and contractor unions should educate their members on how to implement circular economy models and concepts into their construction operations, depending on their scenarios. By disseminating knowledge through seminars and conferences, this would improve the expansion and understanding of circularity among practitioners, which would bridge the knowledge gap.

Secondly, it is recommended that a network comprising well-informed construction practitioners interested in adopting circularity into their operations should be built to ensure awareness creation, sharing of ideas, resources, and technological guidance. This has the potential to bring together those who have used (secondary) materials and others who need such materials.

Finally, construction practitioners can ensure that, through their activities, some aspects of circularity are discussed and incorporated at the outset of projects they undertake.

REFERENCES

Adams, K. T., Osmani, M., Thorpe, T., & Thornback, J. (2017). Circular economy in construction: Current awareness, challenges and enablers. *Proceedings of the Institution of Civil Engineers - Waste and Resource Management*, 170(1), 15-24. https://doi.org/10.1680/jwarm.16.00011

Agyekum, K., & Amudjie, J. (2023). Challenges to implementing circular economy: Empirical evidence among built environment firms in Ghana. *International Journal of Construction Management*, 24(3), 281-297. https://doi.org/10.1080/15623599.2023.2222993

Akotia, J., Opoku, A., Egbu, C., & Fortune, C. (2016). Exploring the knowledge 'base' of practitioners in the delivery of sustainable regeneration projects. *Construction Economics and Building*, 16(2), 14-26. https://doi.org/10.5130/ajceb.v16i2.4892

Asante, R., Faibil, D., Agyemang, M., & Khan, S. A. (2022). Life cycle stage practices and strategies for circular economy: Assessment in construction and demolition industry of an emerging economy. *Environmental Science and Pollution Research*, 29(54), 82110-82121. https://doi.org/10.1007/s11356-022-21470-w

Awan, U., Sroufe, R., & Kraslawski, A. (2019). Creativity enables sustainable development: Supplier engagement as a boundary condition for the positive effect on green innovation. *Journal of Cleaner Production, 226,* 172-185. https://doi.org/10.1016/j.jclepro.2019.03.308

Avitesh, V. N. (2022). Concept of Circular Economy in Building Construction. *Journal of Indian Institute of Architects*. 87(6), 80-85.

Braun, V., & Clarke, V. (2012). Thematic analysis. *APA handbook of research methods in psychology, Vol 2: Research designs: Quantitative, qualitative, neuropsychological, and biological*, 57-71. https://doi.org/10.1037/13620-004

Dworkin, S. L. (2012). Sample size policy for qualitative studies using in-depth interviews. *Archives of Sexual Behavior*, 41(6), 1319-1320. https://doi.org/10.1007/s10508-012-0016-6

Eberhardt, L. C., Birkved, M., & Birgisdottir, H. (2020). Building design and construction strategies for a circular economy. *Architectural Engineering and Design Management*, 18(2), 93-113. https://doi.org/10.1080/17452007.2020.1781588

Ellen MacArthur Foundation. (2015, January). Growth within: A Circular Economy Vision for a Competitive Europe. Ellen MacArthur Foundation, Isle of Wight, UK.

Frith, H., & Gleeson, K. (2004). Clothing and embodiment: Men managing body image and appearance. *Psychology of Men & Masculinity*, 5(1), 40-48. https://doi.org/10.1037/1524-9220.5.1.40

Górecki, J., Núñez-Cacho, P., Corpas-Iglesias, F. A., & Molina, V. (2019). How to convince players in the construction market? Strategies for effective implementation of circular economy in the construction sector. *Cogent Engineering*, *6*(1). https://doi.org/10.1080/23311916.2019.1690760

Hofmann, F. (2019). Circular business models: Business approach as driver or obstructer of sustainability transitions? *Journal of Cleaner Production*, 224, 361-374. https://doi.org/10.1016/j.jclepro.2019.03.115

Ives, C. D., Abson, D. J., Von Wehrden, H., Dorninger, C., Klaniecki, K., & Fischer, J. (2018). Reconnecting with nature for sustainability. *Sustainability Science*, 13(5), 1389-1397. https://doi.org/10.1007/s11625-018-0542-9

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

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling*, 127, 221-232. https://doi.org/10.1016/j.resconrec.2017.09.005

Lieder, M., & Rashid, A. (2016). Towards circular economy implementation: A comprehensive review in context of the manufacturing industry. *Journal of Cleaner Production*, 115, 36-51. https://doi.org/10.1016/j.jclepro.2015.12.042

Mandel, T., Kranzl, L., Popovski, E., Sensfuß, F., Müller, A. & Eichhammer, W. (2023). Investigating pathways to a net-zero emissions building sector in the European Union: what role for the energy efficiency first principle? Energy Efficiency, 16, 22. https://doi.org/10.1007/s12053-023-10100-0

Manninen, K., Koskela, S., Antikainen, R., Bocken, N., Dahlbo, H., & Aminoff, A. (2018). Do circular economy business models capture intended environmental value propositions? *Journal of Cleaner Production*, 171, 413-422. https://doi.org/10.1016/j.jclepro.2017.10.003

McKinsey and Company, (2021, June.,18th) Call for action: Seizing the decarbonization opportunity in construction. [Online]. Available: https://www.mckinsey.com/industries/engineering-construction-and-building-materials/our-insights/call-for-action-seizing-the-decarbonization-opportunity-in-construction.

Mensah, J. (2019). Sustainable development: Meaning, history, principles, pillars, and implications for human action: Literature review. *Cogent Social Sciences*, 5(1). https://doi.org/10.1080/23311886.2019.1653531

Morseletto, P. (2020). Targets for a circular economy. *Resources, Conservation and Recycling*, 153, 104553. https://doi.org/10.1016/j.resconrec.2019.104553

Najjar, M. K., Figueiredo, K., Evangelista, A. C., Hammad, A. W., Tam, V. W., & Haddad, A. (2019). Life cycle assessment methodology integrated with BIM as a decision-making tool at early-stages of building design. *International Journal of Construction Management*, 22(4), 541-555. https://doi.org/10.1080/15623599.2019.1637098

Norouzi, M., Chàfer, M., Cabeza, L. F., Jiménez, L., & Boer, D. (2021). Circular economy in the building and construction sector: A scientific evolution analysis. *Journal of Building Engineering*, 44, 102704. https://doi.org/10.1016/j.jobe.2021.102704

Oke, A., Aghimien, D., Aigbavboa, C., & Musenga, C. (2019). Drivers of sustainable construction practices in the zambian construction industry. *Energy Procedia*, 158, 3246-3252. https://doi.org/10.1016/j.egypro.2019.01.995

Peel, K. L. (2020). A Beginner's Guide to Applied Educational Research using Thematic Analysis, Practical Assessment, Research, and Evaluation, 25(2), 1-15. DOI: https://doi.org/10.7275/ryr5-k983

Reike, D., Vermeulen, W. J., & Witjes, S. (2018). The circular economy: New or refurbished as CE 3.0? — Exploring controversies in the conceptualization of the circular economy through a focus on history and resource value retention options. *Resources, Conservation and Recycling*, 135, 246-264. https://doi.org/10.1016/j.resconrec.2017.08.027

Repp, L., Hekkert, M., & Kirchherr, J. (2021). Circular economy-induced global employment shifts in apparel value chains: Job reduction in apparel production activities, job growth in reuse and recycling activities. *Resources, Conservation and Recycling*, 171, 105621. https://doi.org/10.1016/j.resconrec.2021.105621

Riley, N. E. (2010). Book review: Steinar kvale and svend Brinkmann, interviews: Learning the craft of qualitative research interviewing (2nd edition). Thousand Oaks, Ca: Sage, 2009. 354 pp. (including index). Isbn 9780761925422. *Qualitative Research*, 10(3), 390-392. https://doi.org/10.1177/14687941100100030608

Rubin, H. J., & Rubin, I. S. (2012). *Qualitative interviewing: The art of hearing data*. SAGE Publications.

Sauvé, S., Bernard, S., & Sloan, P. (2016). Environmental sciences, sustainable development and circular economy: Alternative concepts for trans-disciplinary research. *Environmental Development*, 17, 48-56. https://doi.org/10.1016/j.envdev.2015.09.002

Többen, J., & Opdenakker, R. (2022). Developing a framework to integrate circularity into construction projects. *Sustainability*, *14*(9), 5136. https://doi.org/10.3390/su14095136

UNEP (2023). CO2 emissions from buildings and construction hit a new high, leaving sector off track to decarbonize by 2050: UN (unep.org). (n.d.). UNEP (2023). CO2 emissions from buildings and construction hit a new high, leaving sector off track to decarbonize by 2050: UN (unep.org).

Webster, K. (2017). *The circular economy: A wealth of flows - 2nd edition*. Ellen MacArthur Foundation Publishing.

Yi, S., Wu, N., Luo, P., Wang, Q., Shi, F., Zhang, Q., & Ma, J. (2008). Agricultural heritage in disintegration: Trends of agropastoral transhumance on the southeast Tibetan Plateau. *International Journal of Sustainable Development & World Ecology*, 15(3), 273-283. https://doi.org/10.3843/susdev.15.3:10

Yu, Y., Xu, J., Zhang, J. Z., Wu, Y., & Liao, Z. (2022). Do circular economy practices matter for financial growth? An empirical study in China. *Journal of Cleaner Production*, 370, 133255. https://doi.org/10.1016/j.jclepro.2022.133255