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Achieving Circular Economy Adoption in the Construction Industry: Hurdles to Cross in a Developing Country

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ABSTRACT

Sustainability and the ability to manage waste in the construction industry are critical to the construction industry efficiency. It is also important as it preserves the environment. The study adopted a quantitative approach via a well-structured questionnaire to identify the barriers to achieving the circular economy in the South African construction industry. Data was collected from construction industry professionals. The data collected was analysed, and the findings reveal that lack of education and awareness, lack of penalties on illegal dumping, and lack of knowledge of Circular Economy principles are the three most significant barriers to achieving Circular Economy in the construction industry. The study is important as it provides insight into the hurdles to overcome in achieving Circular Economy.

Keywords: Resource efficiency, Sustainability, Developing country, Optimisation

INTRODUCTION

The construction of new structures and the rehabilitation and refurbishment of existing systems produce a lot of waste which must be combated to promote sustainability. The usage of material resources increases with population growth and threatens the availability of such resources for future generations; the application of circular economic principles promotes sustainability. The construction industry is increasingly under pressure to produce an adequate infrastructure to cater to the ever-growing world population with limited resources. During the construction industry activities, major environmental concerns include land degradation, landfill depletion, carbon and greenhouse gas emissions, water pollution, high energy usage, and resource depletion through construction and demolition waste creation and the manufacturing of building materials. The circular economy concept has been shown to provide sustainability gains and achieve substantial economic gains, thereby causing economic growth (Korhonen, Honkasalo and Seppälä, 2018).

The concept promotes utilisation, waste prevention, resource efficiency, reusability and recyclability. The circular economy concept has not been given a singularly accepted definition globally. Various researchers and institutions have adopted diverse definitions and perspectives to explain it; however, the

crux concerns sustainability, efficiency and resource management. Several studies have proposed definitions; for instance, Nobre and Tavares, (2021) describe it as an economic system targeting zero waste and pollution throughout the material lifecycle. For Prieto-Sandoval, Jaca and Ormazabal, (2018) irrespective of the perspective of the author, the definition of the circular economy must include four components; these are recirculation of resources and energy, the importance for achieving sustainability, must state the close relationship with the innovation of the society and the approach must be multi-level. Similarly, Merli, Preziosi and Acampora, (2018) opined about the multi-dimensional nature of the circular economy concept. They are of the opinion that it consists of various subdivisions which must be aptly captured. Geissdoerfer *et al*., (2017) defined the circular economy as a regenerative system whereby the minimisation of resource waste, emission and energy leakage is ensured through slowing, closing and narrowing material and energy loops. Therefore, the continuous evolvement of this concept requires a standardised definition that captures its scope and communicates its essence in a simplified manner. However, the absence of this definition does not affect its adoption's inherent benefits.

The inherent benefits in the circular economy concepts thus provide the construction industry with the needed solution by reducing the usage of raw materials, safeguarding material resources, and lowering the carbon footprint: it allows construction materials, goods, and components to be reused and recycled while preserving their value. In achieving its adoption throughout the building lifecycle, Rahla, Mateus and Bragança, (2021) presented a framework throughout the product stage, construction process stage, use stage and end of life stage. The framework incorporates the use of BIM at the use stage. This was well explored by Charef, (2022) where the author made a case for the use of BIM in the circular economy concept.

This study is aimed primarily at investigating the barriers to the adoption of a circular economy in the construction industry in a developing country. The next section explores existing literature on barriers to the adoption of circular economy, the methodology section, findings and conclusion follow this.

BARRIERS TO CIRCULAR ECONOMY ADOPTION

Hart *et al*., (2019) categorised the barriers to achieving circularity in the built environment into cultural, regulatory, financial and sectoral. Cultural barriers are concerned with the social, behavioural and managerial contexts, while the study identified the regulatory barriers as those concerned with policy and regulations. Other classifications based on financial and market-related (financial barriers) and the sectorally peculiar barriers unique to the construction industry are classified as sectoral barriers. Through a literature review, Charef, Morel and Rakhshan, (2021) classified it into economical, sociological and environmental based on the tripod basis for sustainable development. Other classifications adopted by the study are technical, organisational and political. Other barriers include knowledge among stakeholders, CE evaluation methodology, Uncertainty and risk (Hossain *et al*., 2020). In a study

on prioritising the barriers to circular economy in construction and demolition waste management, Mahpour, (2018) identified agency and ownership issues, a lack of integration of sustainable construction and demolition waste management, among others, as barriers.

In understanding the barriers to circular economy in the construction industry, it has thus been researched from different perspectives and contexts. The aforementioned studies explored the barriers from diverse perspectives. They tried to categorise and identified these barriers in a bid to provide deeper insights. Some provided barrier-tailored drivers and solutions; the various solutions are thus based on the individual barriers identified. It is worthy of note that a recurring barrier is the challenge of regulation and policy.

METHODOLOGY

The study adopted a quantitative approach to achieve its objectives. A questionnaire well structured was distributed to construction industry professionals. Table 1 provides background information on these professionals. The data was collected from 103 respondents within the South African construction industry. The quantitative approach is a proven approach that researchers in the construction industry have widely adopted to provide a good understanding of various challenges in the construction industry in different subject areas(Oladiran and Onatayo, 2019; Aliu and Aigbavboa, 2020; Aghimien *et al*., 2022; Akinradewo *et al*., 2022; Ikuabe *et al*., 2022; Adekunle *et al*., 2022). To understand the data collected, different analyses were performed. The reliability was tested using the Cronbach Alpha, a value of 0.970 was achieved, showing that the instrument is reliable. The normality of the data set was tested using the Shapiro-Wilk test. The results revealed that the significance value (p) was less than 0.05 (Table 2). This indicated that the data did not follow a normal distribution. Furthermore, a Kruskal Wallis test was conducted to compare the responses based on the professional groups. The results indicated that there is no significant difference in the responses of the professionals as the value achieved are all greater than 0.05 (Pallant, 2010; Aliu *et al*., 2022).

FINDINGS

Respondents Background Information

Table 1 shows that 46.6% of the respondents possess a bachelor's degree, 6.8% possess a diploma, and 33% possess an honours degree. In comparison, 7.8% possess a master's degree, and 5.8% have other qualifications. From the respondents, 3.9% were construction supervisors, 20.4% were engineers, 1.9% were environmentalists, 3.9% were health and safety agents/managers, 2.9% planners, 16.5% were project/construction managers, 41.7% were quantity surveyors. In terms of industry experience, 40.8% possess 1 to 5 years of experience, 7.8% had an experience between 11 and 15 years, 3.9% of the respondents had an experience between 16 and 20 years, 20.4% had an experience of 6 to 10 years while 3.9% of them had an experience of more than 20 years, 23.3% had an experience of under one year. The table

Table 1. Background information of respondents.

Qualification	**Frequency**	**Percent**
Diploma	7	6.8
Bachelors degree	48	46.6
Honors	34	33
Masters	8	7.8
Others	6	5.8
Profession	Frequency	Percent
Quantity surveyor	43	41.7
Construction supervisor	2	1.9
Engineer	21	20.4
Environmentalist	2	1.9
HSE professional	15	14.6
Planner	3	2.9
Project/Construction manager	17	16.5
Years of Experience	Frequency	Percent
Under one year	24	23.3
1–5 years	42	40.8
6–10 years	21	20.4
11–15 years	8	7.8
16–20 years	4	3.9
More than 20 years	4	3.9
Organisation	Frequency	Percent
Consultant	26	25.2
Contractor	52	50.5
Government	11	10.7
Self employed/Entrepreneur	4	3.9
Others	10	9.7
Location	Frequency	Percent
Gauteng	76	73.8
Free state	1	1
Eastern cape	4	3.9
Kwazulu natal	4	3.9
Limpopo	4	3.9
Mpumalanga	4	3.9
Northern cape	3	2.9
Northwest	2	1.9
Western cape	5	4.9

also shows that 25.2% work in a consulting environment, 50.5% work for a contractor, 10.7% for the government, 3.9% are self-employed, and 9.7% for other types of organisations not listed. The study was based in South Africa; respondents were asked to state the province in which the organisation they work is located. 3.9% of the respondents are in Eastern Cape, 1% are in Free State, 73.8% in Gauteng province, 3.9% in KwaZulu-Natal,

Table 2. Analysis of barriers.

Barriers	Kruskal-Wallis H	Asymp. Sig.	Shapiro-Wilk		Mean	Std. Deviation	Rank
			Statistic	Sig			
Lack of circular economy construction-based education and awareness	5.794	0.122	0.806	0.000	4.12	0.932	1
Lack of understanding of the potential of CE principles	4.463	0.216	0.822	0.000	3.91	0.876	2
Lack of penalties/sanctions on illegal dumping	5.551	0.136	0.843	0.000	3.89	0.959	3
Lack of interest, knowledge, and engagement	0.900	0.825	0.838	0.000	3.84	0.988	4
High upfront costs	2.033	0.566	0.858	0.000	3.84	1.073	5
Lack of regulations and laws	3.552	0.314	0.866	0.000	3.83	1.043	6
Lack of collaboration between businesses and business functions	4.083	0.253	0.865	0.000	3.83	0.961	7
Lack of regulatory mechanism	2.841	0.417	0.860	0.000	3.8	1.013	8
Absence of cooperation and information sharing among stakeholders	3.340	0.342	0.870	0.000	3.79	0.967	9
Inadequate financial resource	1.039	0.792	0.867	0.000	3.78	1.047	10
No statutory frameworks for material recovery	4.947	0.176	0.877	0.000	3.77	0.982	11
Stakeholder perception of CE products being inferior to virgin products	4.998	0.172	0.854	0.000	3.76	0.913	12
Lack of standards on the quality of secondary products	2.594	0.459	0.878	0.000	3.75	0.947	13
Fragmented nature of the construction industry	2.453	0.484	0.856	0.000	3.75	0.947	14
Lack of standardisation	2.081	0.556	0.843	0.000	3.73	0.842	15
Lack of guidelines and manuals for sorting and collection	4.532	0.209	0.865	0.000	3.73	1.031	16
Lack of effective CE-based knowledge management systems in the construction industry	5.280	0.152	0.871	0.000	3.73	0.931	17
Waste management legislation and government regulatory measures for CE are not binding or not enforced.	3.320	0.345	0.846	0.000	3.73	0.92	18
Insufficient environmental-friendly instruments	2.098	0.552	0.869	0.000	3.71	1.016	19
The technical challenge related to material recovery	3.372	0.338	0.877	0.000	3.71	0.903	20
Fragmented supply chain	2.389	0.496	0.885	0.000	3.7	0.998	21
Administration and planning expenses are high.	1.698	0.637	0.885	0.000	3.69	1.039	22
Lack of international agreement and a lack of goals like energy efficiency	1.094	0.778	0.863	0.000	3.66	1.062	23
Deconstruction is more complex than demolition.	2.690	0.442	0.876	0.000	3.66	0.913	24
Low virgin material prices	0.442	0.931	0.876	0.000	3.5	0.948	25

3.9% in Limpopo, 3.9% are in Mpumalanga, 2.9% in Northern Cape, 1.9% in Northwest and 4.9% are in Western Cape.

Barriers to Circular Economy Adoption

The results (Table 2) presents the analysis of the barriers. It is noteworthy that all barriers presented to the respondents are significant as they all achieved a value above 3.00. From the table, the top three ranked barriers are lack of circular economy-based education and awareness had a mean of 4.12 and a standard deviation of 0.932. Lack of understanding of the potential of circular economy principles had a mean of 3.91 and a standard deviation of 0.876. The lack of penalties/ sanctions on illegal dumping had a mean of 3.89 and a standard deviation of 0.959. The least ranked barriers include deconstruction is more complex than demolition, which was indexed number twenty-three with a mean of 3.66 and a standard deviation of 0.913. Lack of international agreement and a lack of goals like energy efficiency had a mean of 3.66 and a standard deviation of 1.062. The least ranked barrier, low virgin material prices, had a mean of 3.50 and a standard deviation of 0.948.

The result suggests that the most significant barrier to the adoption of a circular economy is the lack of awareness and education among stakeholders. This is described as the crux and overarching barrier (Hart *et al.*, 2019). Without adequate construction-based circular economy education among the industry stakeholders, it will be difficult to achieve the adoption. It is difficult to adopt or use anything without adequate knowledge. An industry-wide (vertical and horizontal) circular economy is important to inform stakeholders of the circular economy principles. The introduction of circular economy education in the curriculum and continuous professional development courses is also essential.

Also, there is a need for a regulatory framework whereby responsibilities, obligations, penalties and rewards are clearly defined. This framework must affect waste management and adequately penalise defaulters. Like other innovations adopted in the construction industry, respondents also ranked cost as a critical aspect in the adoption of the circular economy. It thus points to the financial and investments aspect of the adoption. It also introduces the aspect of government support through fiscal incentives or support in achieving circular economy.

CONCLUSION

The adoption of circular economy is critical to achieving sustainability in the construction industry. It provides resource efficiency through reduce, reuse, and recycle principles. It thus provides circularity and ensures that there is low consumption and high efficiency in terms of resources consumed in the construction industry. This also speaks to the limited resources available to the construction industry and lowers the negative environmental impact through industry activities. The findings of this study reveal that the most significant barrier is the lack of circular economy awareness and education in the construction industry. Other barriers include the lack of circular economy regulatory framework/ policies. There is a need for proper awareness

of circular economy among industry stakeholders. Furthermore, an implementation plan affecting the supply chain is required. Supporting this is the fiscal incentives by the government.

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