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Mapping out focus for circular economy business models (CEBMs) research in construction sector studies – a bibliometric approach

Received 12 October 2023
Revised 28 November 2023
2 February 2024
Accepted 12 February 2024

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Abstract

Purpose – The circular economy business models (CEBMs) provide ways for firms operating in the construction industry to move from a linear to a circular approach. Thus, this study aims to explore CEBM research within the construction sector to show the focus area of studies, highlighting new areas that require attention.

Design/methodology/approach – This study adopted a bibliometric approach, using the Scopus database as the data source. The keywords used for paper extraction from the database were "circular economy business" OR "circular business" AND "model" OR "models" AND "construction industry" OR "building industry". The VOSviewer software was then used to prepare a co-occurrence and co-authorship map based on the bibliographic data gathered.

Findings – The study's findings reveal five research clusters in the construction industry. These clusters include circular construction intelligence, modular business modelling, eco-construction, sustainable construction economics and smart energy-efficient buildings. The two most cited scholars had two publications each, while the top journals are the *Journal of Cleaner Production* and *Sustainable Production and Consumption*. This study concludes that there is a need for research within the construction sector to focus on CEBMs' archetypes and frameworks. This will enable a smooth transition from linear to circular business models in the sector.

The authors would like to acknowledge the financial support provided by the University of Johannesburg-Commonwealth Bursary, School of Postgraduate Studies, University of Johannesburg, to fund this research.

Journal of Engineering, Design and Technology
Emerald Publishing Limited
1726-0531
DOI 10.1108/JEDT-10-2023-0444

Research limitations/implications – The information was gathered from a single database, Scopus; hence, using other databases, including Web of Science, Google Scholar and Dimensions, might produce more articles for examination and, consequently, different findings on the subject under investigation.

Practical implications – These findings would assist researchers in considering the areas mentioned, which are yet to receive attention, and, by extension, enhance economic development while maintaining environmental sustainability.

Originality/value – This paper made a significant contribution to the body of knowledge by identifying scholars and platforms that have been instrumental in advancing CEBM research and highlighting new areas that require attention in the construction sector.

Keywords Business model, Bibliometric review, Circular economy, Construction industry, Sustainability

Paper type Literature review

1. Introduction

Numerous post-2015 United Nations sustainable development goals (SDGs) studies highlight the pivotal role of the construction sector. This sector is responsible for 40% of global energy consumption and a third of global greenhouse gas (GHG) emissions, largely because of its adherence to the linear economy model (Pearce and Ahn, 2017). This model, characterised by a "take-make-dispose" approach, generates substantial waste, particularly during construction demolition (Charef and Lu, 2021; Abdullahi *et al.*, 2023). In spite of sustainable transitions in other sectors, the construction sector favours the linear model. Consequently, implementing waste hierarchy systems (Rasmussen *et al.*, 2018) or alternative approaches to enhance material efficiency (Chen *et al.*, 2010) and waste management (Soni *et al.*, 2022) are imperative to curb GHG emissions.

Warodell and Lindholm (2016) highlighted the need for an environmentally sustainable development strategy, leading to the emergence of circular economy (CE) models focused on resource conservation and waste elimination in design. Unlike the linear model, CE ensures closed-loop material circulation. Ghisellini *et al.* (2018) noted that adopting CE can mitigate the environmental impact of the construction sector. This was corroborated by van Stijn and Gruis (2019), emphasising the shift from a linear economy to a CE for a resource-effective construction environment. Ruiz *et al.* (2020) argued that CE adoption is perceived as a key to sustainability in the construction sector, in spite of challenges in material recovery because of disposal methods. Hossain *et al.* (2020) raised reservations about CE implementation in construction, possibly stemming from a lack of understanding within the industry. Various factors were identified as additional concerns and barriers, including building nature, fabrication process, client demands, multiple stakeholders and long building life cycles (typically 30–60 years) (Charef and Lu, 2021). Oluleye *et al.* (2022) attributed the slow adoption to the absence of comprehensive circular economy business models for organisations to emulate in making necessary adjustments.

CE and circular economy business models (CEBM) share fundamental principles but have distinct focuses. CE emphasises preserving and enhancing materials through reusing, recycling, repairing, refurbishing, remanufacturing and maintenance (Geissdoerfer *et al.*, 2017). CEBM, on the other hand, involves organisations creating value while aligning with CE principles (Lewandowski, 2016). Implementing CE in construction involves resource and waste management to prolong resource lifespan (Oluleye *et al.*, 2022). This approach reduces environmental degradation by decreasing the demand for new materials, enhancing product durability, using alternative materials in manufacturing and bolstering the secondary sector (Agrawal *et al.*, 2022). CE's goal in the construction sector is to enable modern methodologies without environmental degradation, often caused by reliance on virgin materials (Upadhyay *et al.*, 2021). In spite of challenges related to the fragmented adoption of CE principles in the construction sector, adhering to the 10Rs – Reuse, Recycling, Recovery, Reduce, Refuse, Repair, Remanufacture, Refurbish, Repurpose and Replace – will ultimately curtail the sector's environmental impact (Ghisellini *et al.*, 2018).

Oluleye *et al.* (2022) emphasise the pivotal role of models in organisational change. Norouzi *et al.* (2021) stress the necessity of a comprehensive framework for CE adoption, providing a roadmap for success. Salmenperä *et al.* (2021) assert that transitioning to CE is unlikely without such a framework. CEBM, as advocated by Bocken *et al.* (2016) and Desing *et al.* (2020), aims to maximise resource value and minimise waste. Potting *et al.* (2017) explain that a CEBM, guided by CE principles, enhances resource management by reducing natural material consumption. Pomponi and Moncaster (2017) highlight the importance of the end-of-life phase, applying CE's 3Rs to replace traditional approaches. Also, Guerra and Leite (2021) emphasise the need for resource-efficient patterns to promote circularity in construction. Zimmann *et al.* (2016) underscore the pivotal role of project design decisions in efficient end-of-life component and material recovery. In spite of its potential, CEBM faces adoption challenges, including financial constraints (Bocken *et al.*, 2018), infrastructure limitations and regulatory hurdles (Guldmann and Huulgaard, 2020), as well as a dearth of CEBM frameworks in the construction sector (Oluleye *et al.*, 2022).

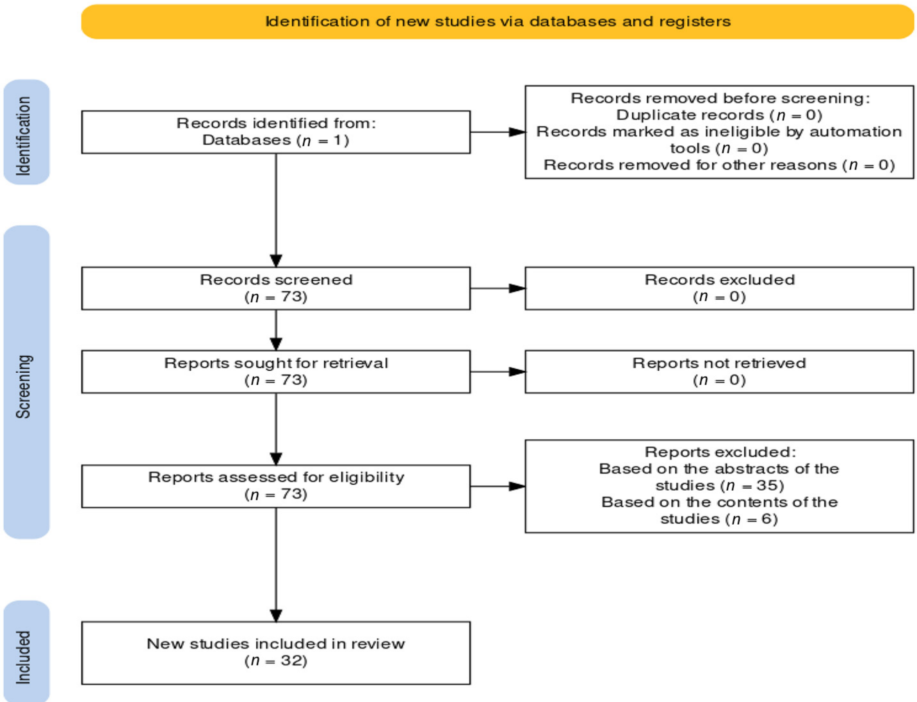
CEBMs will facilitate construction firms to transition from linear to circular approaches, fundamentally altering how organisations create, capture and deliver value (Lewandowski, 2016). These models emphasise retaining economic value through product reuse, recycling and remanufacturing (Urbinati *et al.*, 2017). CEBMs also advocate for product access over ownership, encouraging organisations to engage in responsible product use and disposal (Antikainen and Valkokari, 2016). While various CEBMs have been adapted from the manufacturing sector, their adoption remains limited, particularly in the construction sector. This reluctance stems from internal and external barriers, hindering the integration of CE principles in a sector vital for reducing pollution and environmental degradation, especially in developing nations (Hina *et al.*, 2022). Consequently, analysing CEBMs' in the construction sector context will likely provide insight into new discussions on this subject. It could provide guidance for future scholars looking to enter this academic discourse. As far as the researchers know, no studies have used bibliometric analysis to focus solely on CEBMs, authors and clusters from the construction sector. Thus, this study adopts a bibliometric analysis of CEBM studies to achieve the following objectives:

- *RO1.* To determine the current research focus of CEBM studies.
- *RO2.* To identify the most cited authors.
- *RO3.* To determine the top journals or conferences that have published the most cited articles.
- *RO4.* To identify new research areas that require attention in the construction sector.

By achieving these objectives, this study seeks to unearth a new research area that requires attention for a smooth transition from a linear to a CEBM in the construction sector.

2. Methodology

This study highlights the focus of published works on CEBM in the construction sector. The research identifies key knowledge areas and patterns by adopting a bibliometric approach, a helpful statistical strategy for determining the body of information in a scientific field (Garfield, 1979). Furthermore, the author posits that the method's primary premise is that publication citations accurately reflect the current discourse in the field of research to determine any intellectual structure of interest. However, Culnan (1986) contended that the availability of publications is a determining factor in the citation counts used to assess their influence on forming a knowledge structure, which may restrict the technique's usefulness. However, VA Eck and Waltman (2014) added that the approach also statistically analyses published papers and creates networks based on co-citations, bibliographic coupling, co-authorship, keyword co-occurrences and citation counts. The study used co-citations, co-occurrences and citations to accomplish this goal. The Scopus database was selected for data collection because of its prominence in science research. It is also the largest collection of abstracts and citations (Nobre and Tavares, 2017; Olawumi *et al.*, 2017; Guz and Rushchitsky, 2009). Scopus is recognised for its comprehensive coverage, record overlap with Web of Science and frequent use in review articles (Vieira and Gomes, 2009; Chadegani *et al.*, 2013; Olawumi *et al.*, 2017). Additionally, it offers broader coverage than other databases (Hosseini *et al.*, 2018). The keywords used for the search were ("Circular Economy business" OR "Circular business") AND ("Model" OR "Models") AND ("Construction Industry" OR "Building Industry"). A total of 73 articles were initially retrieved, of which 32 were retained for analysis based on the abstracts and contents of the studies. The data was graphically analysed using Vosviewer, a suitable software for bibliometric literature reviews (Van Eck and Waltman, 2019). The study also used a meta-synthesis analysis to gain deeper insights into the concept under study (Spicer *et al.*, 2021; Hughes-Morley *et al.*, 2015). Fig. 1 illustrates the adopted framework.



Source: Haddaway *et al.* (2022)

Figure 1.
Methodology framework

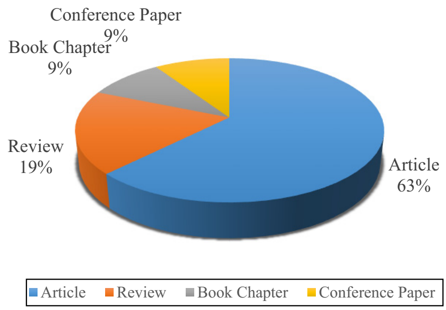
3. Result and discussion

3.1 Document type

This study analysed 32 articles on CEBMs, with 63% being journal articles, 19% being review articles, 9% being from conference proceedings and 9% from book chapters (Figure 2). In spite of the development of the CE concept by Turner and Pearce (1990) and various business models such as circular suppliers (Lacy *et al.*, 2014; EMF, 2015), maintenance and repairs (Lacy *et al.*, 2014; WRAP, 2015; Bakker *et al.*, 2014; Planing, 2015) and upcycling (Lacy *et al.*, 2014; Mentink, 2014; Planing, 2015), research on CEBMs in the construction sector remains in its early stages. Promising research areas within the sector include reusable modular components with structural interlocking mechanisms, offering flexibility and resilience.

3.2 Publications per year

Figure 3 illustrates the number of publications by year, highlighting the emergence of CEBMs in the construction sector. In 2018, only one publication existed on this topic, but 2019 saw an increase to two publications, followed by a continued rise in 2020 (7 publications) and 2021 (12 publications). However, there was a decline in 2022



Source: Authors' own work

Figure 2.
Document type

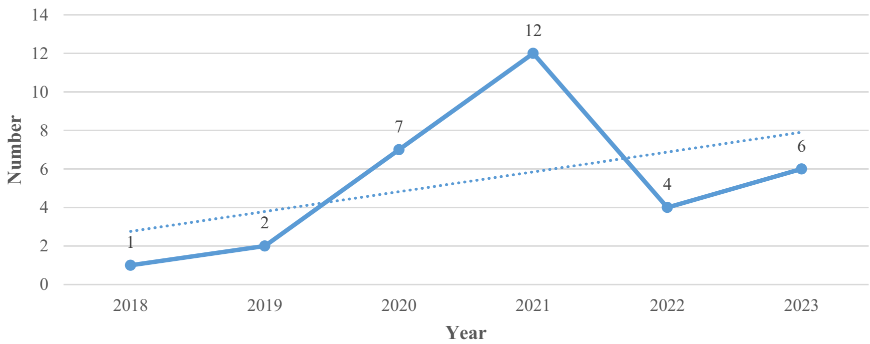


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Figure 3.
Publications per year

(four publications), while 2023 already saw six publications. This data underscores the nascent research stage in integrating CE principles into construction business models. Norouzi *et al.* (2021) emphasise the importance of developing a comprehensive framework for CE integration, while Agrawal *et al.* (2022) argue that CE principles can mitigate environmental degradation by reducing material demand, enhancing product durability and promoting raw material substitution.

3.3 Publications per country

This study examined publications by country of origin, including all nations, even those with only one published article within the specified years. The rationale for this inclusion is that some countries garner numerous citations from a single article because of the relatively new nature of the concept in the construction sector. Figure 4 reveals that The Netherlands leads in publications with 5 articles and 93 citations, followed by Italy (4 articles, 159 citations), India (4 articles, 145 citations), the UK (4 articles, 79 citations), Portugal (3 articles, 148 citations), Australia (3 articles, 34 citations), Brazil (2 articles, 147 citations), Denmark (2 articles, 85 citations), Sweden (2 articles, 94 citations), Hong Kong (2 articles, 36 citations) and Chile (2 articles, 8 citations). Countries such as Belgium, Canada, Germany, Norway, Oman and Spain have one article with several citations. Notably, in spite of the UK having the most CE publications in the construction sector, with Italy in second place (Ossio *et al.*, 2023), The Netherlands leads in CEBM publications. Additionally, Figure 4 reveals that among the top five countries, four are European, aligning with Osobajo *et al.*'s (2022) findings that European countries are at the forefront of CE research, likely attributed to the European Union Circular Economy Plan introduced in 2015 by the European Commission, as highlighted by McDowall *et al.* (2017).

3.4 Publications per source of document

Table 1 shows that the 32 papers from various sources shed light on the current landscape of CEBM research. Among the sources evaluated, it is noteworthy that the *Journal of*

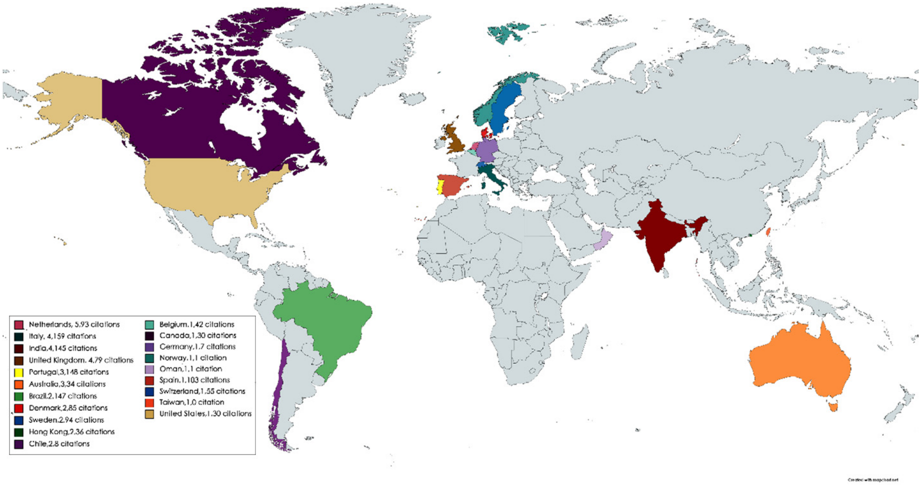

Figure 4. Publications per country

Source: Authors' own work

Cleaner Production emerges as a prominent platform for CEBM research. This journal demonstrates a significant focus on resource efficiency and waste reduction. The high citation count suggests that the research published in the *Journal of Cleaner Production* has contributed to scholarly discourse and garnered attention and recognition within the academic community. Following closely is the *Sustainable Production and Consumption Journal*. This indicates a robust engagement with CEBMs, aligning with the journal's thematic focus on sustainable production practices. The substantial citation count suggests that the research published in this journal has resonated well within the academic community, signifying its impact and relevance. Finally, in spite of having a smaller number of publications, the Proceedings of the Institution of Civil Engineers Engineering Sustainability and Facilities journal demonstrates a growing interest in CEBM research within the construction sector. The citation counts indicate that these contributions have been recognised and contribute to the evolving discourse on sustainable practices in the construction sector.

3.5 Publications most cited

This study analysed 32 construction publications on CEBM, identifying three highly cited publications (Table 2). The articles predominantly cover business models, implementation strategies, digital technologies, industrial design, policies/strategies, building information systems, waste trading and circularity adoption. For example, Nußholz *et al.* (2020) identified a company that adopted an innovative business model for gathering and recycling three material streams – secondary wood, glass and concrete – from urban material stockpiles. New products made from these materials were produced for a construction project. Furthermore, Guerra *et al.* (2021) identified some CEBM strategies in the construction industry, including design for modularity, disassembly and remanufacturing. This indicates a strong focus on developing suitable CEBM archetypes for the sector and leveraging digital technologies. This is crucial, as CEBM aims to optimise resource use and minimise waste. Given the substantial waste generated in construction, especially during demolition and end-of-life phases, research in this area is imperative (Desing *et al.*, 2020; Potting *et al.*, 2017; Charef and Lu, 2021). However, the prevalent methods used are reviews and case studies, which suggest that CEBM research is still emerging in the construction industry.

3.6 Publications based on author and co-authors network

The 32 publications assessed had 105 authors, including lead and collaborating authors. Nine authors contributed to two publications, while 96 had one publication each. Table 3 highlights the top authors in the construction domain's CEBM articles, such as Bragança, L.

Source	Documents	Citations
Journal of Cleaner Production	7	287
IOP Conference Series Earth and Environmental Science	3	10
Sustainability	3	68
Sustainable Production and Consumption	3	174
Built Environment Project and Asset Management	2	23
Facilities	1	17
Journal of Building Engineering	1	103
Proceedings of the Institution of Civil Engineers Engineering Sustainability	1	34

Source: Authors' own work

Table 1. Publications per source with citations

Source	Title	Citations	Method	Focus
Munaro *et al.* (2020)	Towards circular and more sustainable buildings: A systematic literature review on the circular economy in the built environment	138	Review	Business models
Mhatre *et al.* (2021)	A systematic literature review on the circular economy initiatives in the European Union	120	Review	Implementation strategies
Norouzi *et al.* (2021)	Circular economy in the building and construction sector: A scientific evolution analysis	105	Review	Emerging trend
Çetin *et al.* (2021)	Circular digital built environment: An emerging framework	57	Review	Digital technologies
Dokter *et al.* (2021)	How circular is current design practice? Investigating perspectives across industrial design and architecture in the transition towards a circular economy	52	Qualitative study	Industrial design
Giorgi *et al.* (2022)	Drivers and barriers towards circular economy in the building sector: Stakeholder interviews and analysis of five European countries policies and practices	43	Qualitative study	Implementation policies/ strategies
Nußholz *et al.* (2020)	Material reuse in buildings: Implications of a circular business model for sustainable value creation	43	Case study	Business model
Rose and Stegemann (2018)	Characterising existing buildings as material banks (E-BAMB) to enable component reuse	34	Review	Building information system
Antwi-Afari *et al.* (2021)	A review of the circularity gap in the construction industry through scientometric analysis	33	Review	Circularity strategies
Guerra *et al.* (2021)	Circular economy applications in the construction industry: A global scan of trends and opportunities	31	Review/case study	Circular business model
Ratnasabapathy *et al.* (2021)	Exploring the barriers for implementing waste trading practices in the construction industry in Australia	21	Review/ quantitative study	Waste trading

Source: Authors' own work

Table 2.
Publications per citations

(2 publications, 147 citations), Munaro, M.R. (2 publications, 147 citations), Tavares, S.F. (2 publications, 147 citations), Mhatre, P. (2 publications, 128 citations) and Campioli, A. (2 publications, 56 citations). Furthermore, Bibyan, Boer, and Cabeza each have one publication cited 120, 105, and 105 times, respectively. Figure 5 displays the co-authorship network cluster in the overlay visualisation. The earliest researchers in CEBM for construction were MacKenbach, S., Zeller, J.C., Osebold, R., Rose, C.M. and Stegemann, J.A., starting in 2020 (depicted in deep blue). The most recent publication's authors are Zhuang, G.-L., Shih, S.-G. and Wagiri, F., published in 2023, in yellow on the map.

3.7 Focus of research based on co-occurring keywords

A minimum number of keyword occurrences must be specified to generate a co-occurrence map from bibliographic data. This ensures proper keyword grouping, revealing research

Affiliation	Authors	Documents	Citations
The University of Hong Kong	Antwi-Afari, P.	2	36
Institute for Sustainability and Innovation in Structural Engineering	Bragança, L.	2	147
Politecnico di Milano	Campioli, A.	2	56
Politecnico di Milano	Giorgi, S.	2	56
Politecnico di Milano	Lavagna, M.	2	56
National Institute of Industrial Engineering	Mhatre, P.	2	128
Universidade de São Paulo	Munaro, M.R.	2	147
Pontificia Universidad Católica de Chile	Ossio, F.	2	8
Universidade Federal do Parana	Tavares, S.F.	2	147
Western Sydney University	Alashwal, A.	1	21
National Institute of Industrial Engineering	Bibyan, S.	1	120
Maastricht University School of Business and Economics	Bocken, N.	1	57
Universitat Rovira i Virgili	Boer, D.	1	105
Universiteit Twente	Braakman, L.	1	8
Universitat de Lleida	Cabeza, L.F.	1	105
Glasgow Caledonian University	Callaghan, N.	1	1

Source: Authors' own work

Table 3. Publications based on author network

themes. While Vosviewer's default is five co-occurring keywords, Saka and Chan (2019) used two and Aghimien *et al.* (2020) used four. This study chose two to avoid too few keywords. The requirement was a minimum of two co-occurrences in source and author-indexed keywords. Five clusters emerged from 57 keywords that met this criterion. Proximity influences co-occurrence frequency (Van Eck and Waltman, 2014). Figure 6 depicts a network visualisation of these 57 co-occurring keywords, with CE and the construction industry at the centre.

- Cluster 1 – Circular construction intelligence: The red region on the map in Figure 6 contains 15 co-occurring keywords, including artificial intelligence, building, built environment, circular design, circular business models, circular strategies, circular economy, construction, life cycle analysis, manufacturing, numerical model, planning, product design and sustainability. This cluster of studies focuses on integrating artificial intelligence and information technology into the construction sector's CEBMs (Demestichas and Daskalakis, 2020). Cloud computing, distributed computing and edge computing are identified as potential accelerators of the transition to a CE in the sector, offering dynamic resource access (Mell and Grance, 2011). Also, Big data is pivotal in driving CE adoption, involving massive and intricate databases from various sources (Adekunle *et al.*, 2023a). Machine learning is also crucial, enabling adaptable algorithms (Adekunle *et al.*, 2023b) and material effectiveness. Intelligent robotics and building information modelling are highlighted as essential technologies (Sarc *et al.*, 2019; Demestichas and Daskalakis, 2020; Adekunle *et al.*, 2023c; Otasowie *et al.*, 2023a) for waste management optimisation and improving building component traceability and adherence to CE principles (Swift *et al.*, 2017). However, overcoming barriers to technology adoption (Otasowie *et al.*, 2023b) is vital for successfully implementing artificial intelligence in construction organisations' CEBMs.
- Cluster 2 – Modular business modelling: The green region on the map in Figure 6, characterised by 12 co-occurring keywords, including building life cycle, building

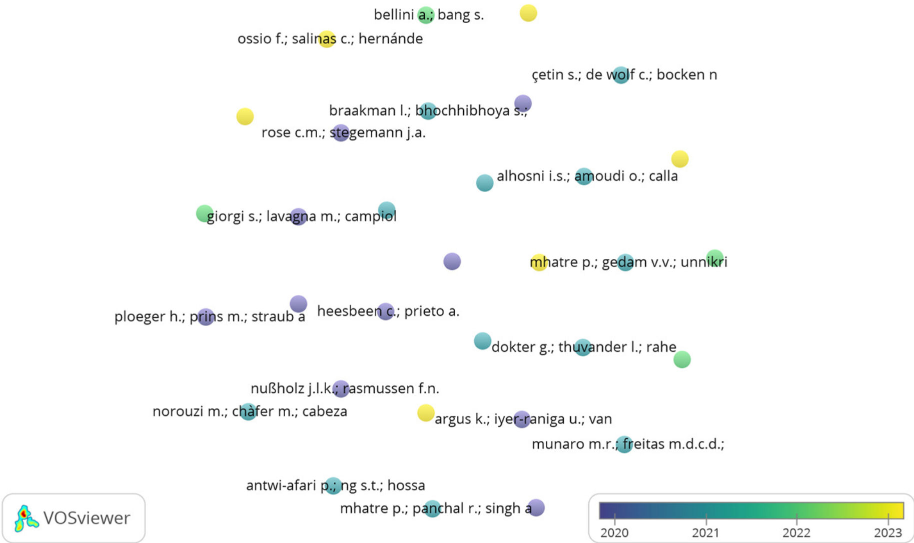

Figure 5.
Visualisation overlay of co-authorship network

Source: Authors' own work

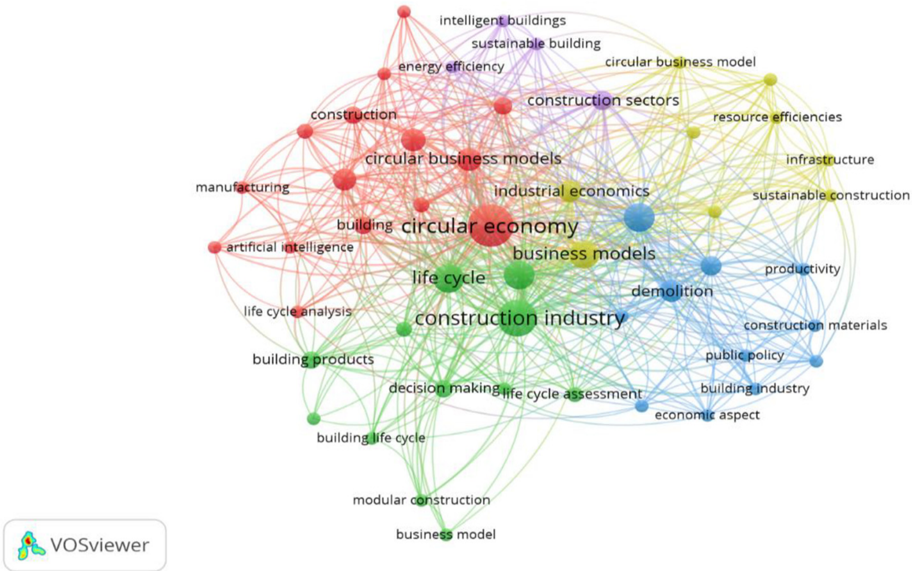

Figure 6.
Network visualisation map for co-occurring keywords

Source: Authors' own work

products, business model, business modelling, circular construction, decision-making, construction industry, environmental impact, life cycle, modular construction and sustainable development, focuses on integrating modularity and prefabrication into construction business models to promote CE practices (Deluxe Modular, 2019). Modular construction involves manufacturing building components in a factory and then assembling them on-site. At the same time, deconstruction facilitates module disconnection for potential reuse, and recycling involves dismantling module parts to recover clean materials (O'Grady *et al.*, 2021; Guerra *et al.*, 2021). By adopting these practices, construction organisations can enhance circularity and minimise construction demolition waste.

- Cluster 3 – Eco-construction: The blue region on the map in Figure 6, is characterised by 11 co-occurring keywords, including the building industry, construction and demolition waste, construction companies, construction materials, demolition, economic aspect, life cycle assessment, infrastructure, productivity, public policy, recycling, waste disposal and waste management, demonstrating a clear connection to eco-construction. Eco-construction emphasises efficiency and recyclability in material and construction method selection, aiming to transform buildings into repositories of valuable resources. This transition involves changes in value chains, designs, markets, customer behaviour models and demolition waste recycling methods (Ghaffar *et al.*, 2020). In spite of the construction sector's reputation for lagging in innovative practices and most CE studies focusing on short-lived consumer goods (Adams *et al.*, 2017), this study affirms the growing attention given to incorporating CE principles into construction business models. Additionally, some studies (Zeng *et al.*, 2022; Hartley *et al.*, 2020; Zhu *et al.*, 2019; McDowall *et al.*, 2017) highlight the role of policies in promoting eco-construction, as various policy strategies have been identified as practical tools for fostering recycling within the construction sector (Jin *et al.*, 2019).
- Cluster 4 – Sustainable construction economics: The yellow region in Figure 6 encompasses nine co-occurring keywords, including business models, circular business models, construction and demolition waste, industrial economics, infrastructure, resource efficiencies, structural design and sustainable building. This cluster of studies emphasises the economic principles underlying CEBMs within construction organisations, aiming to enhance resource efficiency in the construction sector (Myers, 2022). Over the past decade, heightened environmental concerns and resource scarcity have spurred interest in the CE model across various sectors. Given that the construction sector still predominantly follows the resource-intensive "take-make-dispose" linear economic model, with limited resource recovery (Anastasiades *et al.*, 2020), this study affirms a growing focus on sustainable construction economics. The objective is to attain resource efficiency, foster social progress and promote economic growth while protecting the environment.
- Cluster 5 – Smart energy-efficient buildings: The purple region on the map in Figure 6 represents a cluster with only four co-occurring keywords, including construction sectors, energy efficiency, intelligent buildings and sustainable buildings. This cluster focuses on adopting renewable energy and CEBMs to achieve smart energy-efficient buildings. The construction sector faces challenges related to energy use, decarbonisation, energy poverty and the finite supply of fossil fuels (Santamouris, 2016). Therefore, studies in this sector are now emphasising renewable energy as a

business model to combat climate change and fossil fuel depletion. Decarbonisation and increased renewable energy production align with sustainable and net-zero energy-building goals (NZEBs). Saidani *et al.* (2019) proposed that a CE strategy maximises resource use and accelerates the transition to cleaner and more efficient energy sources. Kalchenko *et al.* (2019) stated that a CE strategy would include the following in the energy sector: "designs, processes, and solutions that maximise the efficient use of natural resources for energy production, end use of energy, excess energy and side streams".

3.8 Focus of research based on publication year

The overlay visualisation network map based on the research focus trend is shown in Figure 7. It is crucial to note the minimum requirement of two keyword occurrences. The figure indicates that from 2020 to early 2021, research on CEBMs in the construction sector primarily centred on sustainable and intelligent buildings, encompassing keywords such as buildings, built environment, intelligent buildings, sustainable buildings, life cycle analysis and business modelling, represented in the purple cluster. In the subsequent period from 2021 to early 2022, the focus shifted towards a comprehensive exploration of CEBM. CEBM emerged as the central theme, likely driven by global sustainability concerns and alignment with SDGs and offering significant business opportunities. Keywords during this phase included circular business model, construction industry, business models, industrial economics, circular economy, building life cycle, construction sector, construction materials, waste disposal, structural design, waste management, life cycle, sustainable development, circular strategies, sustainability, decision making, building industry, modular construction, building products, product design, energy efficiency and circular design, depicted in the green area. Subsequently, from 2022 to 2023, research continued on the same trajectory, focusing on sustainable

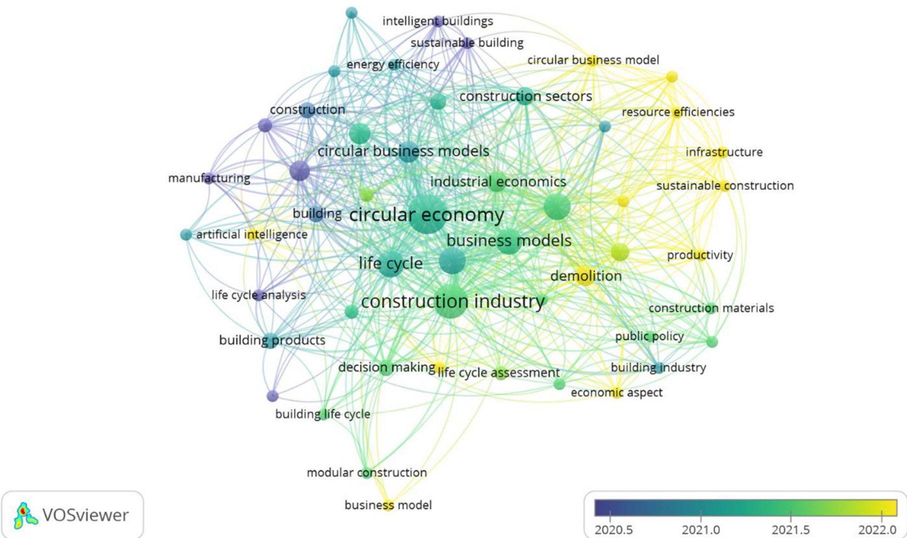

Figure 7. Overlay visualisation map for co-occurring keywords

Source: Authors' own work

infrastructure and the end-of-life management of buildings through CEBM. Keywords in this period comprised circular construction, artificial intelligence, demolition, construction companies, business model, infrastructure, resource efficiency, circular business model, economic aspect and productivity, illustrated in the yellow section. These trends underscore an intensified research emphasis on CEBM in the last two years, as evidenced in studies by Ratnasabapathy *et al.* (2021) on waste trading, Giorgi *et al.* (2022) on policies and practices and Dokter *et al.* (2021) on industrial design. Notably, none of the extracted publications have delved into circular business model archetypes for the construction sector, which Yip and Bocken (2018) defined as innovative value propositions. Additionally, none of the studies on CEBM have addressed a framework facilitating the transition from a linear to a circular business model for organisations, a crucial aspect emphasised by Oluleye *et al.* (2022) in implementing transformative changes. Lastly, while review studies have their merits, a dearth of empirical studies was noted. Qualitative or quantitative empirical studies hold greater potential for aiding the transition from a linear to a circular business model in the construction sector by providing data grounded in observation and measurement of existing and novel approaches.

The circular economy (CE) is not a new concept, with the Ellen MacArthur Foundation being credited for its early conceptualisation (EMF, 2015). The foundation defined CE as an industrial system designed to be restorative or regenerative, emphasising waste elimination through improved material design and business models. CEBMs offer a transition from linear to circular approaches in industries such as construction, focusing on value creation, capture and delivery for organisations (Lewandowski, 2016). Derived from CE principles, CEBMs draw from various frameworks, with the ReSOLVE (Regenerate, Share, Optimise, Loop, Virtualise, Exchange) framework by the EMF (2015) being a prominent example. These six elements represent crucial business actions and opportunities: regeneration for sustainable resource use, sharing to maximise product life span, optimisation for efficiency, looping to keep materials in circulation, virtualisation for virtual service delivery and exchange to upgrade materials. Implementing these strategies in the construction sector can significantly drive CE adoption (EMF, 2015).

The construction sector's rapid resource extraction and waste generation necessitate the adoption of CE through business models. To achieve this, research must focus on circular business model archetypes tailored for the construction sector (Pieroni *et al.*, 2020). Archetypes represent solutions or configurations of CE components, guiding the arrangement of mechanisms for specific goals such as sustainability (Bocken *et al.*, 2014). Thus, there is a crucial need for CEBM research within the construction sector to shed light on this area, enabling modified economic value approaches. This shift will enhance resource efficiency, close energy and resource loops and present new business opportunities (Bocken *et al.*, 2016; Den Hollander and Bakker, 2016). By developing CEBM archetypes in the construction sector through research, entrepreneurs will be incentivised to prioritise sustainability, fostering economic development while protecting the environment.

Furthermore, developing circular business model archetypes is crucial for the construction industry's transition to CE (Oluleye *et al.*, 2022). However, there is a notable gap in research concerning developing a comprehensive framework for this transition. This underscores the need for a framework that guides existing organisations in adopting CEBM, aligning construction clients' needs and financial capacity, defining business responses and creating value through the design and operation of the value chain. Such a framework could facilitate a closed-loop production process, enabling the recovery and reuse of materials or their composting for environmental benefit. As research in CEBM expands, addressing this gap becomes increasingly imperative in the construction sector (Oluleye *et al.*, 2022).

4. Conclusion

This study conducts a bibliometric analysis to examine the research focus of CEBMs in the construction sector, using publications indexed in the Scopus database from 2020 to 2023. The research identifies key focus areas and highlights the need for further investigation. The study reveals that CEBM research in the sector emerged in 2018 with one publication, reaching its peak in 2021 with 12 publications, underscoring the urgency for more research in this crucial area. The study also identifies prominent countries contributing to this research, including The Netherlands, Italy, India, the UK, Portugal, Australia, Brazil, Denmark, Sweden, Hong Kong and Chile. The research clusters focus on circular construction intelligence, modular business modelling, eco-construction, sustainable construction economics and smart energy-efficient buildings. However, no publications or clusters address circular business model archetypes or a transition framework from linear to circular models within the construction sector. This indicates a need for exploration in these areas. Additionally, most studies rely on review methodologies, with empirical studies being relatively scarce. Addressing these gaps will align the construction sector with the SDGs and unlock numerous business opportunities through enhanced resource efficiency and closed energy and resource loops. By developing CEBM archetypes in the construction sector through research, entrepreneurs will be incentivised to prioritise sustainability, fostering economic development while protecting the environment. Finally, this study contributes to current knowledge by pinpointing key focus areas of CEBM research in the construction sector and highlighting potential research areas. However, caution is advised when generalising the results, as the data was exclusively sourced from the Scopus database. While there may be some overlap with other databases, further research using other databases is recommended for a more comprehensive understanding of this subject.

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