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LEAN INTEGRATED BUSINESS MODEL FOR CONSTRUCTION: A SYSTEMATIC REVIEW ON CURRENT PRACTICES AND FUTURE DIRECTIONS

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ABSTRACT

The construction industry plays a critical role in economic and social development but continues to face challenges such as inefficiencies, cost and time overruns, and client dissatisfaction. Lean Construction has emerged as a promising philosophy aimed at minimising waste and maximising value in construction processes. However, widespread adoption remains hindered by barriers such as resistance to change and resource limitations. Integrating Lean Construction principles into Business Models (BM)s referred to as Construction Business Models (CBMs) presents a strategic opportunity to enhance productivity and optimise value creation. Hence there is research gap in construction industry this paper aims to analys the literature on Lean Construction, BMs, and their integration within the construction industry to bridge this research gap. To address this, a systematic literature review (SLR) was conducted, examining publications from databases such as Scopus and Taylor & Francis. Using targeted search terms, 75 documents were initially retrieved, and after filtering, 61 publications were selected for comprehensive analysis. This study explores the integration of Lean Construction within BMs to optimise value in construction projects, offering insights into strategic frameworks that can overcome current inefficiencies. By examining Lean Business Models (LBMs) and their application in construction, the paper contributes to a deeper understanding of how lean principles can drive sustainable business innovation and operational efficiency within the industry.

Keywords: *Business Models (BMs); Construction Business Models (CBM); Lean Business Models (LBMs); Lean Construction.*

1. INTRODUCTION

The construction industry is a key driver of economic and social development, yet it faces persistent challenges such as cost and time overruns, inefficiencies, resource limitations, and client dissatisfaction (Chen et al., 2022; Das et al., 2022; De-Wolf et al., 2023; Kulatunga et al., 2023). To address these issues, innovative management approaches such

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as LC and BMs have gained significant attention (De-Wolf et al., 2023; Goziev, 2022; Rashidian et al., 2023).

Lean Thinking originated in Japan in the 1940s through the Toyota Production System (TPS), developed by Taiichi Ohno. Initially focused on engine manufacturing in the 1950s, it expanded to vehicle assembly in the 1960s and supply chain management by the 1970s (Monden, 2012; Womack et al., 1996). The concept of Lean Production gained global attention by the mid-1980s, aiming to deliver customised products with minimal inventory (Garces & Pena, 2023), and was formalised by Krafcik in 1988. By the 1990s, lean principles extended beyond manufacturing to management and product development (Garces & Pena, 2023), becoming integral to both operational and strategic planning (Lyons et al., 2013).

Lean Construction (LC) evolved from Lean Production as a method to reduce waste and improve project performance (Garces & Pena, 2023; Hamzeh et al., 2021). First conceptualised by Koskela (1992), LC promotes continuous improvement and value delivery (Koskela et al., 2002). It offers a holistic approach focused on reducing waste, enhancing workflow, and meeting client needs (Green & May, 2005). Core LC principles, outlined by Koskela (2004), align with lean thinking and target inefficiencies in construction.

Numerous tools and techniques have been developed to support LC, helping to minimise resource use, time, and cost while maximising value (Zhang & Chen, 2016; Aslam et al., 2022). These tools enhance process efficiency, waste reduction, and project outcomes (Khaskheli et al., 2020; Xing et al., 2021). Studies confirm the effectiveness of LC tools in construction, with over 50 tools identified, varying in application by industry size and project complexity (Li et al., 2020; Issa, 2013; Babalola et al., 2019)

However, the implementation of lean thinking in construction offers a wide range of benefits that contribute to economic, social, and environmental sustainability. Economically, lean thinking promotes continuous improvement in projects and facilitates the timely and cost-effective delivery of products and services by minimising waste (Aslam et al., 2022; Mohammadi et al., 2022). It also helps reduce overall construction costs (Aziz & Hafez, 2013; Babaremu et al., 2022), enhances overall equipment effectiveness (Maradzano et al., 2019), improves project delivery methods and quality (Aslam et al., 2022; Maradzano et al., 2019), and increases both process efficiency and labour productivity (Mohammadi et al., 2022). It further supports managing uncertainties in supply chains (Aslam et al., 2022; Maradzano et al., 2019). Socially, lean thinking strengthens cooperation among stakeholders (Ahmed et al., 2020; Aslam et al., 2022; Maradzano et al., 2019), enhances value creation for improved client and customer satisfaction (Aslam et al., 2022), improves employee satisfaction and supplier relationships (Ahmed et al., 2020; Aslam et al., 2022; Bajjou & Chafi, 2021), and enables the optimal allocation of project resources (Aslam et al., 2022; Maradzano et al., 2019). Environmentally, lean practices promote sustainable development, process optimisation, and waste elimination (Aslam et al., 2022; Maradzano et al., 2019), reduce environmental impacts, and enhance environmental performance (Aslam et al., 2022), while fostering cooperative relationships that support waste reduction (Maradzano et al., 2019; Mohammadi et al., 2022).

Despite the numerous benefits of LC, its implementation is hindered by several interrelated barriers identified across various studies. These barriers can be broadly

categorised into six major groups. Management barriers include poor coordination among project parties (Ahmed et al., 2020; Enshassi et al., 2021; Sarhan et al., 2018), resistance to change by management (Sarhan et al., 2018; Enshassi et al., 2021; Mano et al., 2020), poor project definition (Ahmed et al., 2020; Aslam et al., 2022; Sarhan et al., 2018), and overly centralised decision-making (Ahmed et al., 2020; Babalola et al., 2019; Mohammadi et al., 2022). Financial barriers involve the high cost of implementation (Ahmed et al., 2020; Babalola et al., 2019), the tendency to stick to traditional methods for financial reasons (Moradi & Sormunen, 2023), lack of worker incentives (Ahmed et al., 2020), and issues such as corruption and inflation (Enshassi et al., 2021; Moradi & Sormunen, 2023). Governmental barriers include inadequate support for LC adoption and inconsistent policies (Sarhan et al., 2018; Enshassi et al., 2021). Technical barriers reflect the absence of a long-term philosophy (Sarhan et al., 2018), inadequate planning (Ahmed et al., 2020), and the extended time needed to apply LC techniques (Enshassi et al., 2021). Educational barriers are linked to the shortage of trained professionals, lack of knowledge sharing among organisations, limited interest from academia, and a general lack of awareness and understanding of LC concepts (Moradi & Sormunen, 2023; Musa et al., 2023). Lastly, human-attitudinal barriers stem from employee resistance to change (Huaman-Orosco et al., 2022), lack of client interest (Bashir et al., 2015), and a lack of critical self-reflection to identify areas for improvement (Musa et al., 2023). These multifaceted barriers collectively highlight the organisational, economic, political, technical, educational, and cultural challenges that must be overcome to achieve successful Lean Construction adoption.

To minimise barriers to lean construction implementation, several techniques have been integrated with the lean concept. Among them, BMs can be identified as an innovative method for reducing these barriers, as they serve as strategic frameworks that enable organisations to create, deliver, and capture value (Abeynayake et al., 2022a; Arend, 2013; Das et al., 2023). However, the choice of BM for a specific business depends on various factors, including the nature of the product or service, the target market, and the competitive environment (Ratana et al., 2022). As a result, businesses may either adapt existing BMs to suit their needs or create unique BMs tailored to their specific characteristics and market conditions (Osterwalder et al., 2010; Ratana et al., 2022). The Business Model Canvas (BMC), a widely recognised tool, provides a structured approach to aligning business strategies with operational needs (Barquet et al., 2011; Osterwalder et al., 2010).

The concept of BMs has evolved significantly due to advancements in business practices, technology, and strategic innovation. First introduced in 1957, BMs gained traction in the 1960s (Osterwalder et al., 2005) and became widely recognised in the late 1990s, particularly with the rise of the Internet (Zott et al., 2010). Over time, BMs have extended beyond start-ups, increasingly influencing industries such as construction, where they enhance competitive advantage through technological advancements.

Timmers (1998) made an early contribution by classifying internet-based BMs based on innovation and functional integration. Aho (2013) emphasised that effective BMs incentivise long-term service delivery, align professional goals, and generate sustainable short-term returns. However, BM innovation is often perceived as risky due to potential disruptions, high costs, and uncertain outcomes (Treptow et al., 2022).

BMs in traditional industries like construction play a vital role in reducing inefficiencies and overcoming fragmentation by enhancing value creation and adapting to changing client demands (Girmscheid & Rinas, 2012). The literature identifies key BM components, value proposition, value creation, and value capture as central to delivering and sustaining competitive advantage (Teece, 2018). These are supported by elements such as value offering, target customer, distribution channels, and customer relationships, which shape how value is delivered (Osterwalder & Pigneur, 2010). Operational efficiency is further enhanced through value configuration, partner networks, and core competencies (Kujala et al., 2010). Financial sustainability is addressed via the cost structure, revenue model, and revenue generation logic (Morris et al., 2005), while strategic positioning within the value network ensures long-term relevance and collaboration (Mokhlesian & Holmén, 2012). Together, these elements form a cohesive framework that enables construction firms to create, deliver, and capture value more effectively. However, as a summary, a well-defined BM serves as a comprehensive framework that outlines how organisations create, deliver, and capture value.

In the construction industry there is a requirement to integrating lean principles into construction organisations is essential for reducing waste and enhancing value (Moradi & Sormunen, 2023). However, various implementation barriers persist. A well-defined Lean Business Model (LBM) provides a strategic framework to align value delivery with resource efficiency and customer needs (Balocco et al., 2019; Ramori et al., 2021).

In global context, limited research has explored the integration of LBMs across industries. Existing studies highlight the benefits of applying lean principles within BMs to enhance efficiency and value. For instance, Balocco et al. (2019) proposed a lean framework to optimise digital BMs, while Ramori et al. (2021) demonstrated LBM's potential in the healthcare sector to reduce waste and improve patient outcomes. Similarly, Kates (2014) explored how awards, standards, and lean frameworks can enhance organisational performance and supply chains. Further, Brotcorne et al. (2019) reported improved productivity, client satisfaction, and cost savings through LBM adoption. Sivakumar and Chawla (2022) introduced a decentralised Lean Business Model Canvas, merging lean six sigma and business process management for strategic agility.

In the construction industry, the application of LBMs has been less explored. Therefore, research indicates a need for developing CBMs that integrate Lean principles to enhance productivity and value optimisation in a construction organisation (Abeynayake et al., 2022a). Integrating LC with CBM is crucial for achieving a competitive advantage in the construction sector. However, studies addressing the development of CBMs that are integrated with lean concepts for value optimisation are limited (Abeynayake et al., 2022b; Arend, 2013).

To address the identified research gap, this paper aims to systematically review the implementation of LBMs, the integration of lean construction principles and BMs within the construction industry, with a specific focus on value optimisation for construction companies. By identifying gaps in existing studies, this research contributes to a deeper understanding of integrating lean construction principles through the BM to optimise the value of a construction business. Therefore, this paper consists of the introduction, methodology, the results of the systematic literature review and conclusion.

2. METHODOLOGY

This research employs a systematic review of the literature to evaluate the current state of research on the integration of lean construction and BM concepts in the construction Industry.

To investigate the Integration of BMs in the Construction Industry and optimisation of value through LC implementation, a comprehensive search was conducted across several databases, including Scopus and Taylor & Francis. Scopus and Taylor & Francis were selected for the literature search due to their extensive collections of peer-reviewed journals in construction management, lean practices, and business strategy. Scopus offers broad, multidisciplinary coverage and citation indexing, while Taylor & Francis provides high-quality research in built environment and organisational studies, making both platforms highly relevant to the research focus.

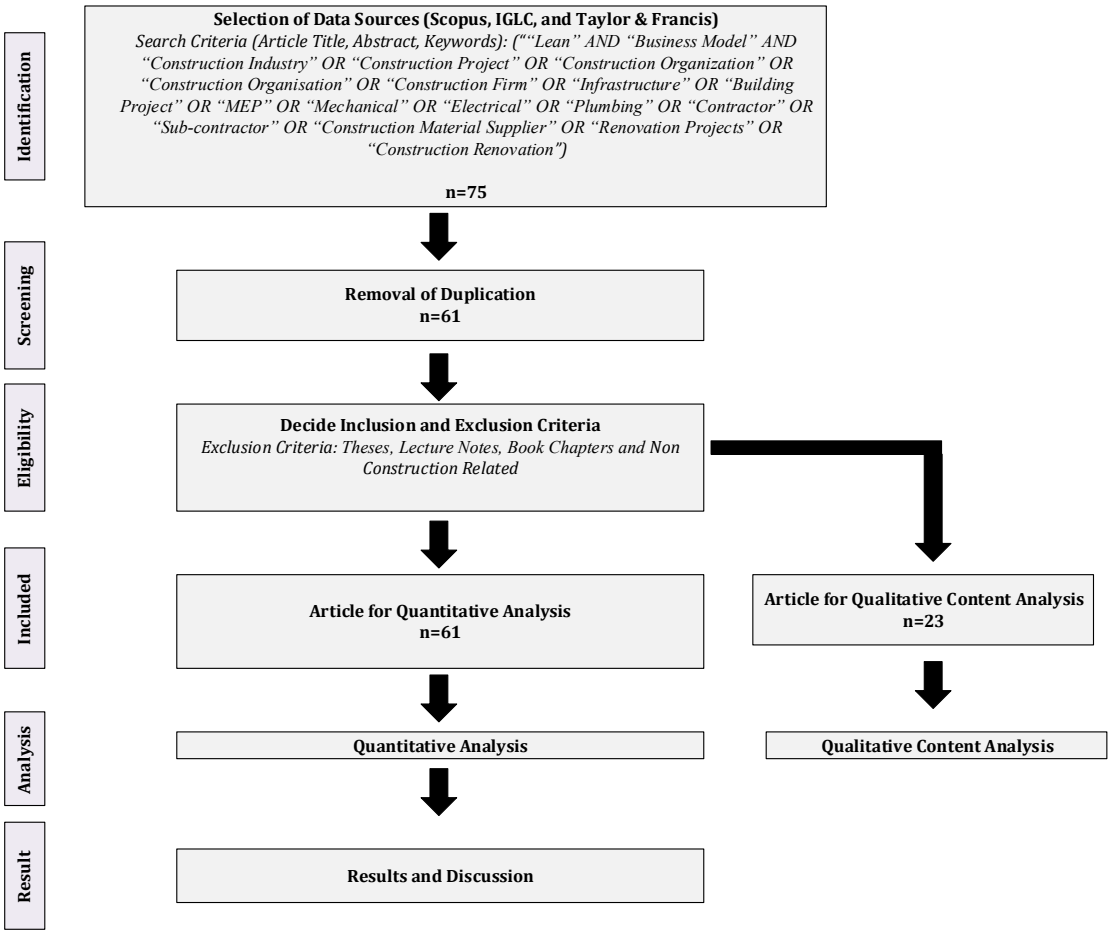

Figure 1: PRISMA protocol for the systematic review process

The initial search, using the terms "Lean" AND "Business Model" AND "Construction Industry" OR "Construction Project" OR "Construction Organization" OR "Construction Organisation" OR "Construction Firm" OR "Infrastructure" OR "Building Project" OR "MEP" OR "Mechanical" OR "Electrical" OR "Plumbing" OR "Contractor" OR "Sub-contractor" OR "Construction Material Supplier" OR "Renovation Projects" OR "Construction Renovation", retrieved 75 documents. After applying additional filtering, 61 unique publications were selected for the SLR. This process excluded duplicates,

theses, book chapters, and lecture materials to ensure the final dataset comprised only peer-reviewed journal articles and conference papers of high academic quality. In the inclusion stage, all 61 articles were subjected to quantitative analysis to examine publication trends, regional distribution, and methodological characteristics, utilising both bibliometric software (VOSviewer) and manual analysis. The overall process is illustrated in Figure 1, which summaries the key steps of the systematic literature review.

3. FINDINGS AND DISCUSSION

This section explores the application of LBMs referring to the integration of lean principles and BMs within the construction industry.

3.1 MAPPING OF RESEARCH WITH PUBLICATION YEARS

Based on the search results, Figure 2 displays the distribution of publications over time, providing a year-by-year analysis of research output.

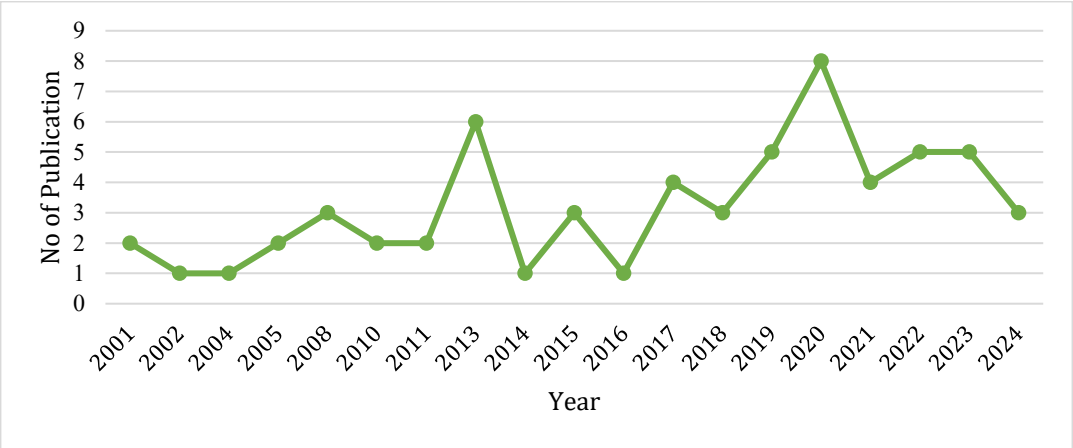

Figure 2: Number of publications over time: trends in lean BM implementation in the construction industry

This figure illustrates the yearly publication trend in different databases from 2001 to 2024. From 2001 to 2011, there was limited interest in the subject area with one (01) to three (03) articles. Since 2013, there has been a noticeable peak in publications, where the number of publications reach seven (07). The period from 2014 to 2019 can be considered as the fluctuating period which annually number of publications varies between one (01) to five (05). According to the graph another peak is shown in the year of 2020, with eight (08) numbers of publications. After the peak in 2020, the number of publications drops slightly and stabilises around three (03) to four (04) publications per year from 2021 to 2023. In 2024, there is a slight decline to two (02) publications, which may indicate a decrease in research output or interest as of this year. However, the shown trend of the publication emphasises that there were two notable peaks (in 2013 and 2020) with periods of fluctuation in between. The publication pattern shown in the graph suggested that this study area has experienced phases of intense research interest, followed by periods of moderate attention.

3.2 MAPPING RESEARCH AREAS ACROSS COUNTRIES

Based on the search results, Figures 3 illustrate the distribution of publications on the implementation of lean BMs in the construction industry across various countries.

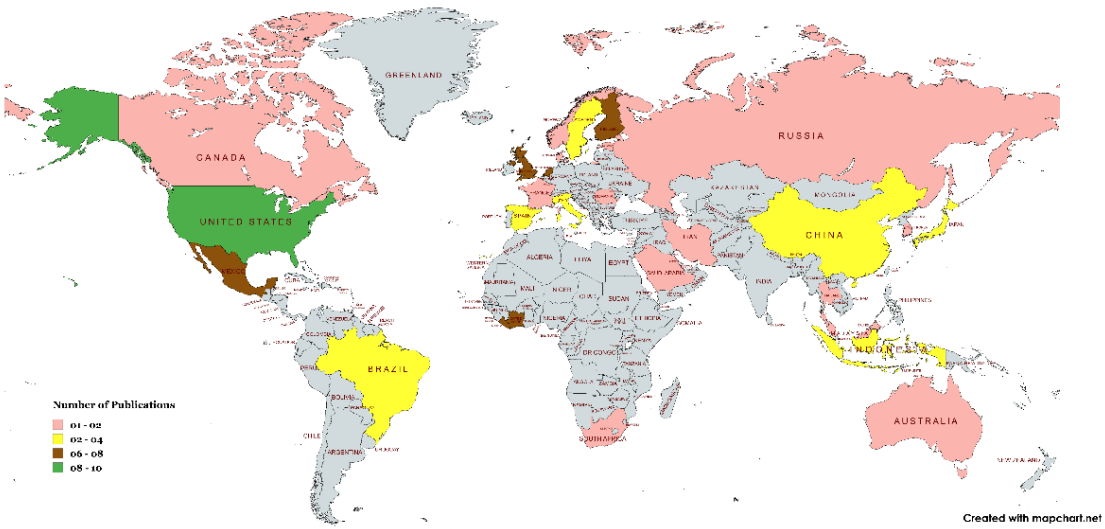

Figure 3: The worldwide spatial distribution of publications on lean BM implementation in the construction industry

The map shows the distribution of lean BM implementation publications in construction sector and is classified according to numbers of publication per country. Highlighted in green, the United States comes out as a major contributor with 9 targeted publications. Brown-highlighted countries are the United Kingdom, Finland and Netherlands, all with 6-7 publications. Yellow indicates countries including Germany and India where there is activity, with 4 to 5 publications from each. Countries with 2 or fewer publication counts (Brazil, China, Spain and Japan) are displayed in light brown. Finally, data from countries like Canada, France and Malaysia is shown in pink. This breakdown provides a spatial perspective of where LC and BM integration research is occurring significant and growing interest in North America, expanding work from Europe, with fledgling contributions emerging out of Asia thereby confirming widespread global attention to the implications of advanced BMs for an industry that has historically been slow to evolve.

3.3 NETWORK MAPPING OF RESEARCH KEYWORDS

A network map of the research area was generated using VOSviewer, emphasising keywords pertinent to this study. To ensure accuracy in the final output, shown in Figure 4, a comprehensive cleaning process was undertaken to eliminate duplicate keywords related to lean BMs.

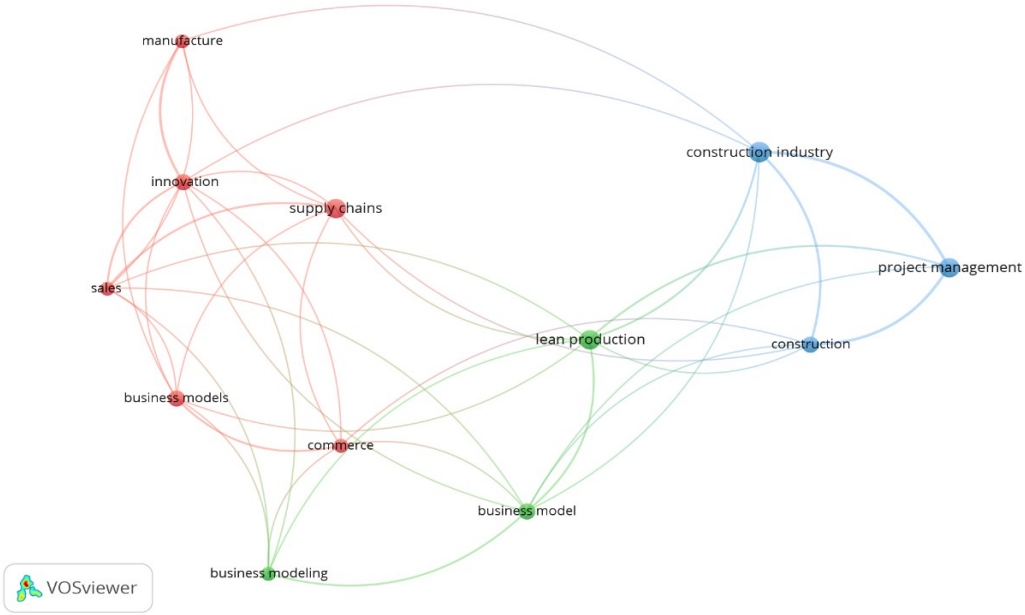

Figure 4: Network visualisation of keywords related to LBM implementation

Figure 4 illustrates a network visualisation of the most frequently used keywords in the selected literature. The size of the nodes reflects the frequency of keyword usage, while the links between them represent the strength of their co-occurrence. The analysis identifies three primary thematic clusters.

Cluster one includes six keywords: BMs, Commerce, Innovation, Manufacture, Sales, and Supply Chain highlighting a research focus on BM innovation within supply chain management and manufacturing processes. Cluster two groups the keywords BM, Business Modelling, and Lean Production, indicating a strong connection between lean principles and BM improvement in construction contexts. Cluster three comprises Construction, Construction Industry, and Project Management, focusing on project execution and management within the sector.

Overall, the network analysis suggests that existing research predominantly addresses the intersection of construction management, lean production, BMs, innovation, supply chains, and manufacturing. However, the diagram also highlights notable research gaps, particularly regarding the integration of lean production and construction management, BM innovation specific to the construction industry, and the combined application of Lean and BM concepts within construction. These gaps suggest significant opportunities for future research aimed at enhancing value creation and operational efficiency through Lean-integrated BMs in construction.

3.4 INTEGRATION OF LEAN BUSINESS MODELS IN CONSTRUCTION INDUSTRY

The concept of the LBM originates from Lean Manufacturing principles, first developed by Toyota in the mid-20th century (Pekuri et al., 2012), and has since evolved into various business contexts, including the Lean Startup methodology. Franke (2004) introduced a lean BM for airline businesses, emphasising cost reduction, revenue generation, and service differentiation. In construction, lean principles require a holistic transformation across value creation, proposition, and revenue systems (Pekuri et al., 2012), exemplified

by Toyota's lean BM approach incorporating business growth, technical coordination, supplier engagement, and waste minimisation. The Lean Startup BM, as discussed by Ide et al. (2015), follows an iterative process for business validation, while Cabrita et al. (2016) explored Lean, Agile, Resilient, and Green (LARG) principles to enhance BM efficiency. Lago et al. (2017) proposed Lean Canvas as a strategic tool for startups, which Balocco et al. (2019) further refined by integrating lean principles into BM change processes. Ghezzi and Cavallo (2020) investigated Lean BM applications in manufacturing and startups, emphasising structured development and value creation. The lean approach has also been applied in healthcare (Ramori et al., 2021), waste management and biofuel production (Moshood et al., 2022), demonstrating its adaptability across industries. Recent advancements include Allen's (2022) Realise Methodology, integrating Design Thinking with lean startups, and Sivakumar and Chawla's (2022) decentralised lean BM utilising blockchain for scholarly communication. In 2024, Tim et al. introduced the Lean Innovation Canvas for SMEs, Zinchenko explored Running Lean in the oil and gas sector, and Reke et al. proposed a Lean Circular BM integrating circular economy principles. These studies collectively illustrate the evolving applications of Lean BM across industries, emphasising efficiency, sustainability, and innovation.

However, existing literature extensively explores LBM implementation across various industries particularly in the context of lean startups limited attention has been given to the construction sector. Given the unique challenges in this industry, integrating BMs with lean construction is crucial for enhancing project value. To address this gap, a systematic literature review SLR was conducted to assess current research and identify areas requiring further investigation. As an initial step in the analysis, a statistical examination is conducted to evaluate publication trends based on two dimensions: publication year and country of origin.

The integration of Lean principles with BMs in the construction industry remains an emerging area of research, with a limited number of studies addressing this intersection. Existing literature highlights various approaches, such as the application of Lean production processes in real-life construction projects through the IKEA BM to optimise construction efficiency (Li et al., 2008) and comparisons between conventional and Lean BMs (Babaremu et al., 2022). Other studies have explored the combination of sustainable BM innovation with user-driven approaches to support Lean startups and examined the role of BMs in construction material recycling in India (Ram et al., 2019). Additionally, the development of the "servitization" canvas has been proposed to help organisations identify new revenue streams in after-sales markets while research has also investigated the integration of Lean principles with platform BMs in Lean startup processes.

The construction industry is undergoing significant transformation, with an increasing emphasis on Lean and sustainable BMs as a means of enhancing efficiency and reducing waste. Furthermore, a growing trend involves integrating Lean principles with BMs to facilitate Lean startup approaches within the sector. The comparative advantages of Lean BMs in minimising waste and improving resource utilisation are further reinforced by their synergy with sustainable innovation and user-driven methodologies, supporting the development of Lean startups in construction (Likita et al., 2022). However, further research is needed to fully explore the potential of Lean BMs in enhancing value creation and optimising construction processes.

4. CONCLUSION

This study underscores the critical role of lean construction and BMs in addressing the longstanding inefficiencies within the construction industry. Lean principles offer considerable economic, social, and environmental benefits, yet their implementation faces several challenges, including management, financial, governmental, technical, educational, and human-attitudinal barriers. The integration of lean principles into CBMs represents a strategic opportunity to enhance value creation and operational efficiency, driving sustainable growth in construction organisations. However, the limited exploration of CBMs in the construction sector implies a need for further research and deeper investigation into how Lean can be integrated with BMs to achieve competitive advantages.

BMs are transforming the construction industry by driving innovation, improving efficiency, and promoting sustainability. Digital, circular, and green BMs are reshaping operations, enhancing value creation, and fostering competitiveness. However, challenges such as resistance to change, skill gaps, financial constraints, and regulatory uncertainties hinder broader adoption. To reveal the full potential of BMs, the industry must focus on innovation, workforce development, and supportive policy frameworks.

The integration of LBMs in the construction sector offers significant potential to enhance efficiency, reduce waste, and foster innovation. While Lean principles have been widely studied in other industries, their application in construction remains relatively underexplored. Existing research suggests that LBMs can optimise value creation, particularly when combined with sustainable practices and user-driven approaches. However, significant gaps remain in fully understanding the potential of LBMs within the construction industry. Therefore, future research should focus on bridging these gaps, exploring practical applications, and developing frameworks that will enable construction businesses to effectively integrate Lean construction principles into their operations, ultimately enhancing both operational efficiency and long-term value creation.

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