

# **Lean Implementation in the Construction Industry**

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## **Abstract**

The paper aims to present an overview of previous research on the application of “lean” in the construction industry, covering key aspects of recent discoveries, their limits, and potential future research directions. It makes two contributions to the body of knowledge. It initially divides the literature to provide an overview of completed research endeavors. Second, it points out a gap in the existing body of research and suggests fresh avenues for investigation. The findings indicate that prior research has had difficulty developing a sound theoretical foundation for the subject. To support the proposed "theories," "notions," and "paradigms," more study is needed. In short, there is a big need for more research because there hasn't been a thorough evaluation of how lean has been used in the construction industry.

## **Keywords**

Lean; Lean Implementation; Construction Industry; Project management; Biblioshiny; Literature Review

## **1. Introduction**

The infrastructure sector is propelling India's overall development and GDP. New policies will result in the creation of world-class infrastructure in time, making it the new global identity of the country. Therefore, investing in sustainable infrastructure and enhancing its quality at an affordable cost should be a guiding principle for the industry. But there is a shortage of skilled labor in the Indian construction industry, which often leads to the quality of a project being questioned (Dinesh et al. 2017). The construction industry displays inefficiency primarily through cost overruns caused by delays in delivery timelines and material waste. Around 15% of all projects are cost overrun, over 70% are time overrun, and about 10% are material waste (Babalola et al. 2019). Currently, in the construction industry, conventional management methods are being replaced by lean management methods, which increase the quality of work and eliminate industry waste (More et al. 2016). “The Lean Construction practice is a method of designing production systems to reduce time, effort, and waste in a construction environment.” The purpose of this study is to summarize prior studies and highlight the significance of lean adoption in the construction industry. The subsequent research questions are created to achieve this goal: “RQ1: How have the concept of lean implementation in construction been investigated in terms of a year, region, research technique, context, and outcomes?” “RQ2: What are the extant literature’s limitations?” “RQ3: What are the future research directions for lean implementation in construction?”.

### **1.1 Objective**

This study provides an overview of the past literature to highlight the importance of lean in the construction industry.

## **2. Literature Review**

Lean construction practices emphasize minimizing waste and materials, contributing to sustainable construction. The lean construction concept is adapted from the Toyota Production System (Anerao and Deshmukh 2016). Lean construction aims to put a significant emphasis on “continuous improvement,” “waste elimination,” “a strong customer focus,” “value for money,” “high-quality project and supply chain management,” and “improved communications” (Singh and Kumar 2020). “Control,” “performance optimization,” “scheduling perspective,” “production system and process,” “performance measurement,” and “customer satisfaction” are some kinds of traditional project management (Kim and Park 2006). It might be difficult to incorporate lean ideas and techniques into building projects and to put them into practice on real building sites. “Lack of understanding of the need for adopting lean construction,” “supply chain uncertainty,” “the propensity to use traditional management,” “culture,” and “human attitude issues (mindset issues),” “a lack of commitment from top management,” and “a non-participative management style for the workforce”

are some of the obstacles to introducing lean principles in India's construction industry (Kim and Park, 2006; Devaki and Jayanthi 2014).

The synthesis of the past literature on lean implementation in construction is shown in Table 1.

Table 1. Synthesis of past literature

<b>Paper Type</b>	<b>References</b>	<b>Aim, Limitation and Future Research Direction</b>
Case Study	More et al., 2016; Walia and Suri, 2017; Anerao and Deshmukh, 2016; Singh and Kumar, 2020; Shastri et al., 2022; Hiwale et. al., 2018; Ramani and KSD, 2019; Vilventhan et al., 2019	<p><b>Aim:</b> These articles have aimed to examine how effectively the Lean methodology works for managing construction projects in the form of a case study.</p> <p><b>Limitation:</b> More research and case studies are essential to developing a roadmap for implementing lean construction in the Gujarat construction industry.</p> <p><b>Future research direction:</b> Future studies might find it helpful to conduct an objective evaluation.</p>
Modelling	Suresh and Nathan, 2020; Kim and Park, 2006; Devaki and Jayanthi, 2014; Kulkarni et al., 2017	<p><b>Aim:</b> These articles have examined the most important factors, barriers, and waste management tools and techniques.</p> <p><b>Future research direction:</b> Based on the identified factors for lean readiness, additional study is needed to create a detailed evaluation model or framework.</p>
Review Paper	Dinesh et al., 2017; Babalola et al., 2019; Singh and Kumar 2020.	<p><b>Aim:</b> These articles aimed to perform a literature review. They aimed to examine the importance of the implementation of lean management.</p> <p><b>Limitation:</b></p>

		<p>It was limited to a literature survey of the existing literature because of various constraints such as limited outreach and time.</p> <p>Future research directions:                  Future studies will focus on applying “visual management.”</p>
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### 3. Methods

We selected 1111 articles from existing literature on lean deployment and twenty-four publications on lean construction's application. We utilized search terms TITLE-ABS-KEY (Lean implementation AND Construction), TITLE-ABS-KEY (Lean AND Construction), and TITLE-ABS-KEY (Lean implementation readiness AND Construction). To ensure that relevant publications were included, we used the search phrases "Lean," "Implementation of lean in construction," "Lean implementation readiness," and "Lean and construction," in the abstract. The main information is shown in table 2. Figure 1 shows the methodology process.

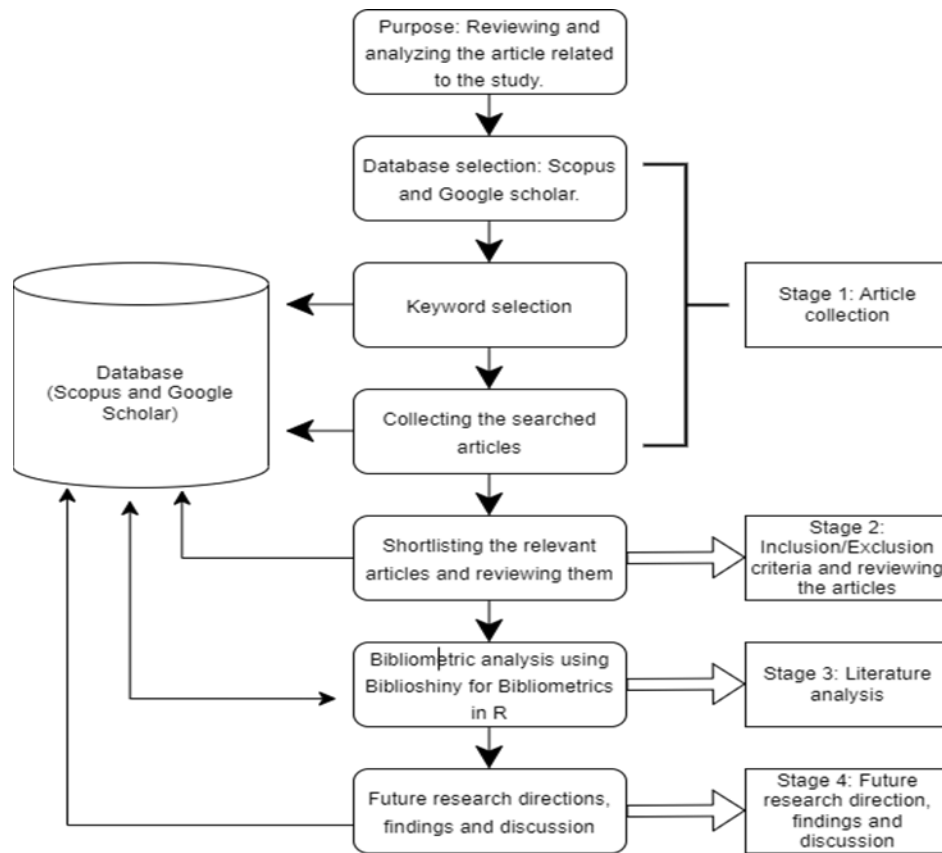


Figure 1. Methodology flowchart.

Table 2. Main information about the data

Description	Result
MAIN INFORMATION ABOUT DATA	
Timespan	1997:2022
Sources	385
Documents	1111
Average years from publication	6.83
Average citations per documents	12.32
References	34332
DOCUMENT TYPES	
Article	394
Book	3
Book Chapter	21
Conference paper	627
Conference review	34
Review	31

#### 4. Results and Discussion

The previous reviews were analyzed using the R programming language's Biblioshiny utility. Figure 2's word cloud illustrates the terminology most frequently employed in construction and lean literature. The most frequently used terms were "construction industry," "lean construction," and "project management." The word cloud displays keywords in various sizes according to how frequently they appear. The order of the phrases is a bit random, but because of their great size, the most significant words are placed in the middle to make them stand out more. A thematic map divided into four topographic zones based on "centrality and density" was also produced (figure 3). From figure 4 it is evident that the study has great potential in the coming years. There was a steep increase in the number of studies published in 2015. In 2015, there were only 56 documents related to lean and construction. Now it has increased to 111 documents in the year 2021. Alarcón, L.F. is the most influential author with 27 documents (figure 5). Alarcón, L.F.'s most cited article was "assessing the impacts of implementing lean construction," with a citation of 85. Also, the United States with 200 documents (figure 6) is the most contributing country to lean implementation.



Figure 2. Word Cloud

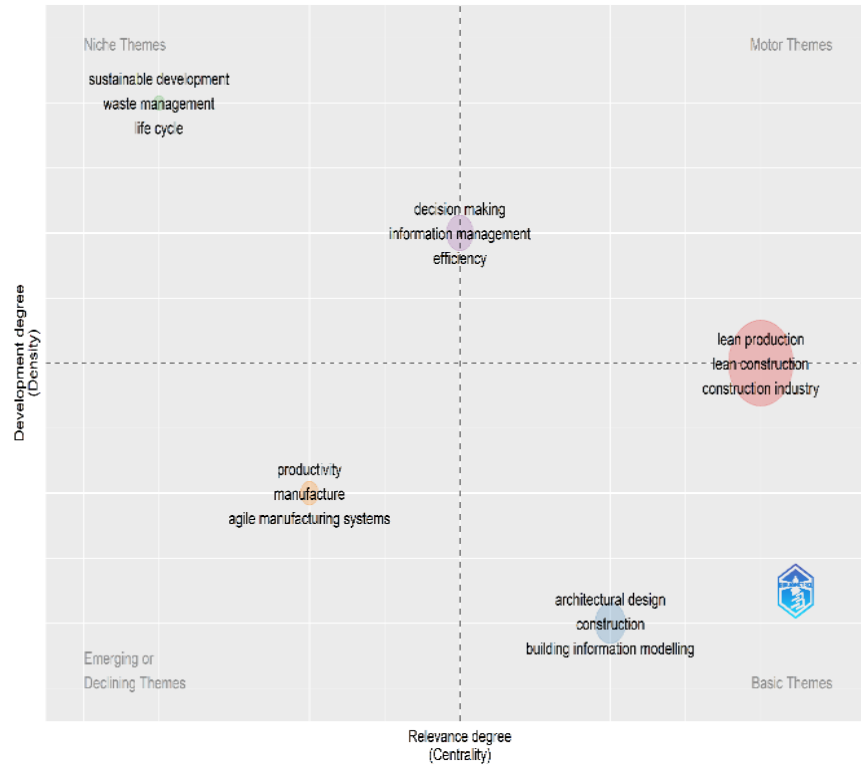


Figure 3. Thematic Map

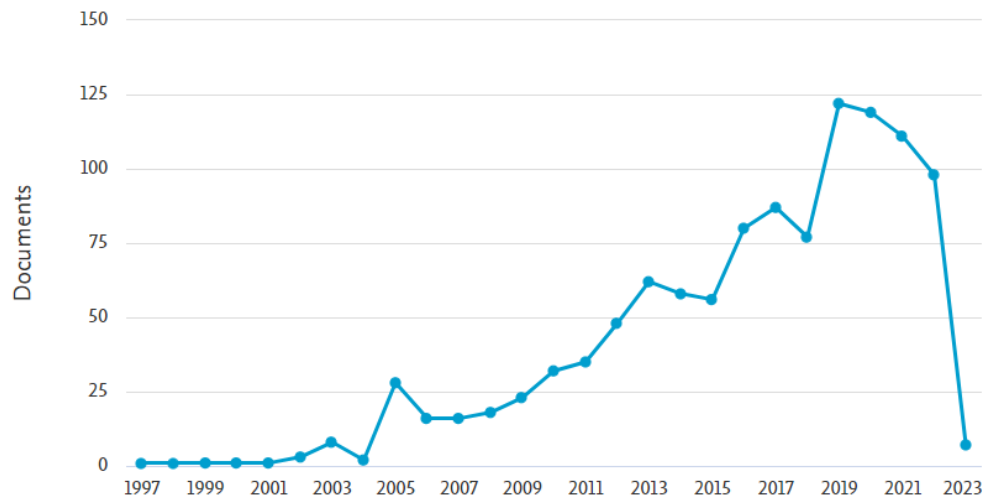


Figure 4. Document by year

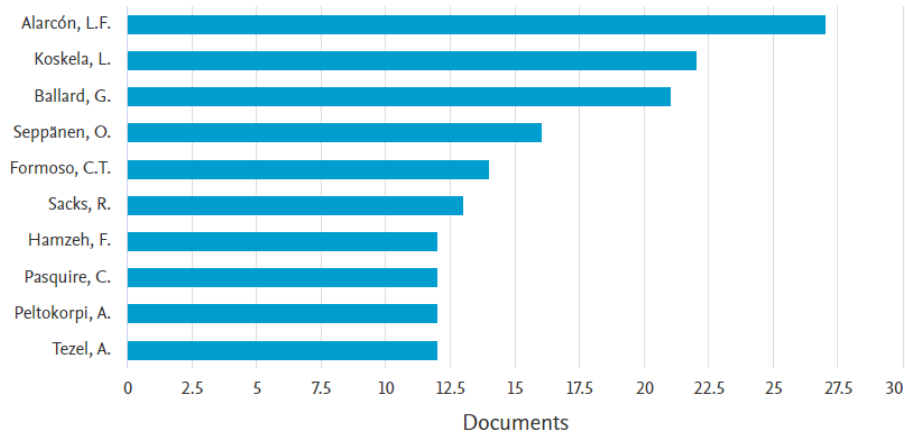


Figure 5. Influential authors

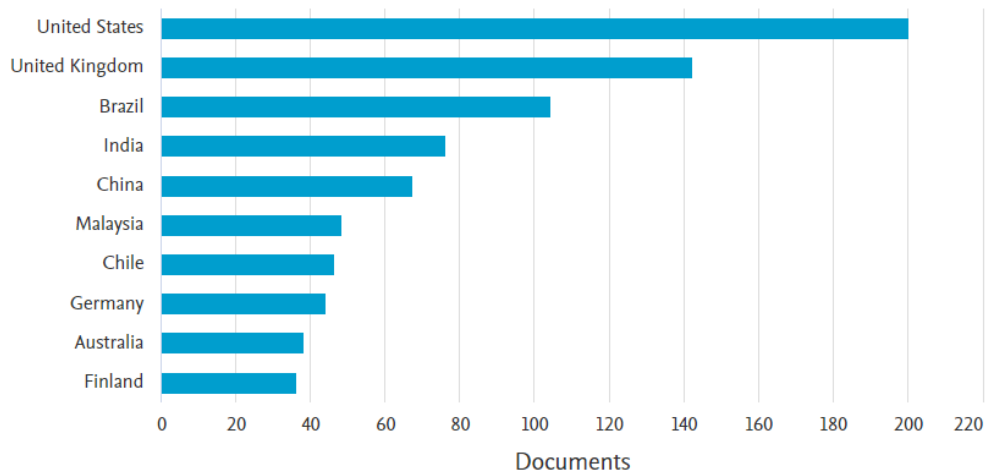


Figure 6. Most contributing countries

It was evident that the primary reasons behind the success of lean construction in India were the organization's culture and systems, top management's commitment, and worksite management. In practice, the advantages of the new manufacturing strategy regarding “productivity,” “quality,” and “indicators were convincing enough to enable the rapid deployment of the novel concepts. Lean development is a method for outlining production frameworks to prevent the waste of resources like time, labor, and materials to generate the most valuable output possible. The construction industry is still growing and has yet to achieve a maturity level for applying lean concepts and practices compared to the manufacturing and service sectors. Lean practices have variously been described as “methods,” “ideas,” “plans,” and plans of action that enable the accomplishment of lean construction goals. The two most popular lean construction practices are “LPS (Last Planner System)” and “JIT (Just in Time). Lean construction practices have helped reduce material waste, which various studies have shown harm the environment. This shows that the perception of construction as a major cause of environmental deterioration could be dramatically changed by applying lean principles.

## 5. Conclusion

Lean is a powerful tool to reduce wastage in organizations (Vignesh and Suresh, 2016, December; Thomas et al. 2017; Thomas and Saleeshya 2019; Raja Sreedharan et al. 2018). In construction, lean should be implemented at several levels. It cannot only be applied at the operational level; it also needs to be planned strategically. To create the most significant use of materials, time, and effort through the implementation of lean development, frameworks are outlined to limit the waste of materials, time, and effort. In this paper lean construction is studied in the context of India. Based on the in-depth study of lean principles/concepts, it was discovered that the lean construction system minimizes waste

and increases productivity in the construction industry. Since lean construction practices are not backed up with proper strategic planning, companies using lean construction tools and practices cannot sustain their use or reap maximum benefits. Taking advantage of a lean system and accepting new construction technologies must be a goal for everyone in the company and on the project for it to be successful. Our construction activities should minimize their environmental impact to achieve sustainable and green growth. An analysis of 24 papers chosen from top-rated journals was conducted via a Systematic Literature Review. Although the number of papers may seem limited, it significantly contributes to this study. The limitation of this study was that past papers rarely discussed limitations and future research directions in their study. Because of various limitations such as limited outreach and time, this study reviewed the existing literature. Since construction is an important sector and is projected to contribute significantly to India's GDP in the future, researchers can explore case studies regarding how different countries, states, or companies have applied lean construction methods efficiently. It may also be necessary to conduct a study to find out which obstacles exist and recommend solutions.

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