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AN OVERVIEW OF LEAN ADOPTION IN THE CONSTRUCTION INDUSTRY: BENEFITS AND BARRIERS

Hyarat, Esraa (1); Casas-Rico, José (1); Montalbán-Domingo, Laura (1); Pellicer, Eugenio (1)

(1) Universitat Politècnica de València

Challenges such as low productivity, waste, safety, and environmental hazards are commonly attributed to existing construction management practices. Based on this, during the last years, there has been a greater understanding of the role that lean construction (LC) plays in achieving better management of construction projects. LC has been accepted as a robust philosophy to achieve cost-saving, project duration reduction, higher safety awareness, sustainability, etc. However, although LC has attracted many companies and practitioners during the last decades, there has been a slow adoption of this philosophy in the construction industry. This paper aims to identify the benefits and barriers to adopting LC practices in the construction industry at the international level. The method is based on a systematic literature review of scientist sources. This research will help increase the understanding of LC implementation and boost its adoption in construction management practices.

Keywords: lean construction; barriers; benefits; construction industry

VISIÓN GLOBAL DE LA ADOPCIÓN DE LEAN CONSTRUCTION EN EL SECTOR: BENEFICIOS Y BARRERAS

Retos como la baja productividad, el desperdicio, la seguridad o los riesgos ambientales se atribuyen habitualmente a las prácticas existentes en gestión de la construcción. Teniendo en cuenta esto, durante los últimos años, se ha percibido más claramente el papel que el Lean Construction (LC) juega en conseguir una mejora en la gestión de las obras. Se ha aceptado LC como una filosofía robusta para conseguir ahorros de coste, reducción de tiempos, mayor concienciación en la seguridad y en la sostenibilidad, etc. No obstante, aunque LC ha atraído a muchas empresas y profesionales durante las últimas décadas, la adaptación de esta filosofía al sector de la construcción ha sido muy lenta. Este artículo tiene por objetivo la identificación de los beneficios y las barreras para la adopción de prácticas LC en el sector de la construcción a nivel internacional. El método utilizado se basa en una revisión sistemática de la literatura científica. Esta investigación incrementará el entendimiento del LC y favorecerá su adopción en las prácticas de gestión de la construcción.

Palabras clave: lean construction; barreras; beneficios; sector de la construcción

Correspondencia: Eugenio Pellicer. Correo: pellicer@upv.es

1. Introduction

All construction industry subsectors, such as building and other infrastructure work, involve a variety of distinct activities that vary in complexity. Several of these activities necessitated a large number of regular and irregular inputs that required considerable coordination. However, the supply chain processes in this industry are not always benefited from these activities, resulting in a lack of productivity and inefficiency. Cost overruns due to waste materials and missed project delivery deadlines are the most obvious signs of inefficiency. Rework was also considered a major source of waste in the construction industry, which is a major cause of the project's high costs and lengthy timeline (Fayek et al., 2004). These and other issues have contributed to the construction industry being classified as a leading non-environmentally friendly endeavor globally. New methods, techniques, and management behaviors that are more environmentally friendly should be used by people in the construction industry (Liu et al., 2019). This will help the industry become more productive and have more access to sustainability. One of the practices was adopted from the Toyota manufacturing industry, which aims to develop and improve the planning system, maintain control over the storage system, and minimize waste (Alarcón, 1997; Shaqour, 2022). This practice is known as Lean construction (LC) and has been extensively studied over the last few decades (Albalkhy & Sweis, 2020; Aziz & Hafez, 2013; Sweis et al., 2016). The LC enables complex, uncertain projects to significantly benefit from production management techniques while also laying the groundwork for a new type of management and lowering the amount of waste generated (materials, time, and cost) (Albalkhy & Sweis, 2020; Babalola et al., 2019). Despite these positive outcomes, LC is still in its infancy and has yet to realize its full potential.

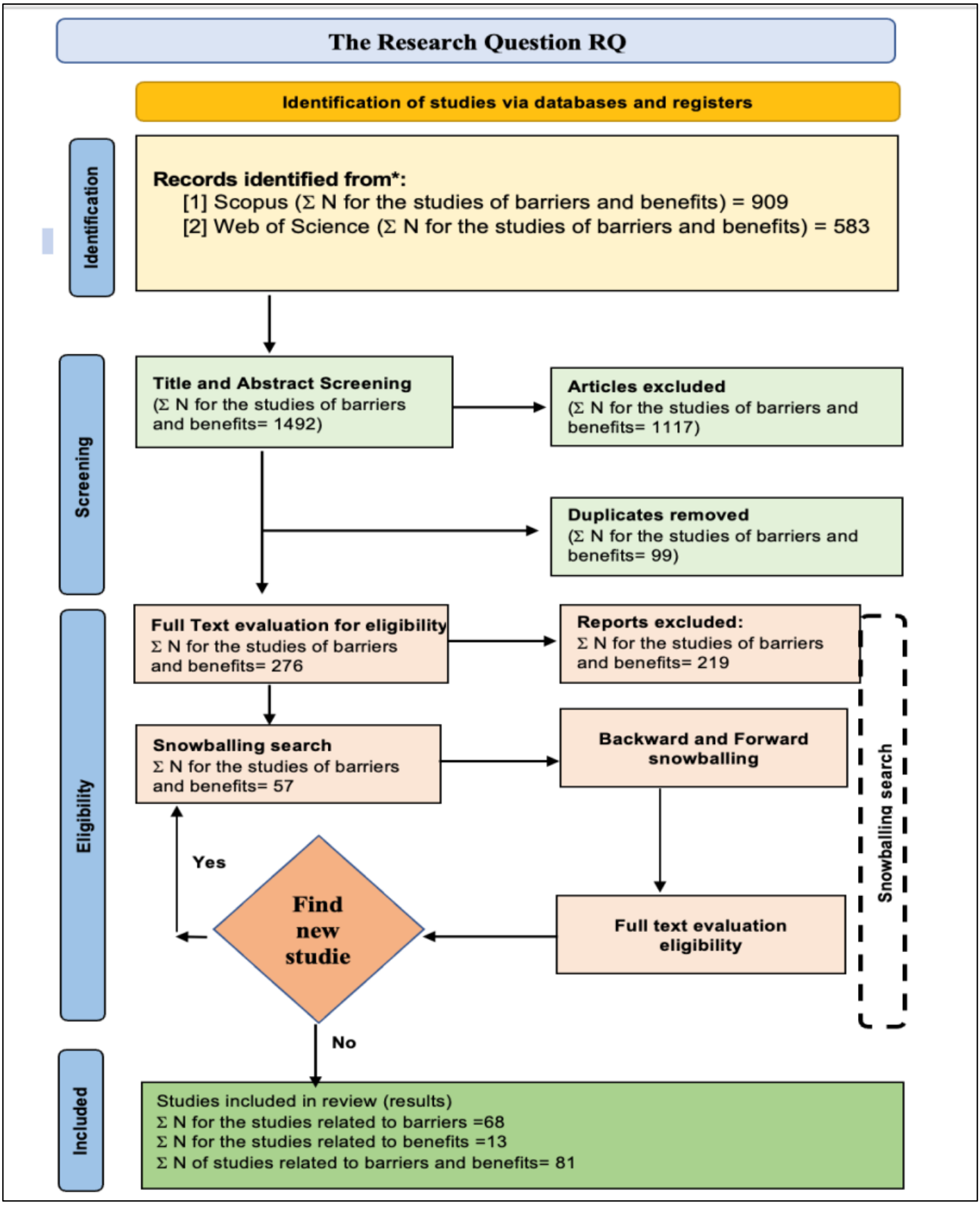
As a result, the purpose of this paper is to provide an overview up to date of the construction industry's use of LC, including its benefits and the barriers to doing it. This paper, unlike the previous systematic reviews, which were solely focused on LC in one country (Kifokeris, 2021; Li et al., 2020), LC for a period of time (Singh & Kumar, 2020), LC with other techniques such as lean and agile (Mostafa et al., 2016), LC with building information modeling (BIM) (Tezel et al., 2020), or LC practices (Babalola et al., 2019). This paper will take a global look at all studies, including the benefits and barriers of LC, helping to increase knowledge in this area, as well as a better understanding of the LC situation, especially the benefits of it that can help stakeholders decide whether or not to adopt it. The systematic review of the literature (SLR) methodology will be used as a means to identify, select, and evaluate the relevant literature. This paper is divided into four sections, including this introduction; the second section discussing the SLR that will be used to evaluate and select the articles; the third section including the results descriptive analysis; the final section presents the conclusion of this work.

2. Methodology

This research aims to provide a comprehensive summary through the SLR methodology. The primary benefit of the SLR is that it identifies gaps in the field of study, highlights the research methodology used in the defined research to improve future work in the topic area, and finally provides a clear answer that helps define the area where additional research is not required. The success of the SLR methodology is contingent on five steps (Tawfik et al., 2019). The first step establishes the research questions (RQs), which give weight to the SLR and its shown in the main objective: an examination of the state of the existing knowledge in the literature that is related to LC adoption. The primary objective is characterized by two questions:

RQ1: What are the barriers to LC adoption as reported in the literature?
RQ2: What are the benefits of LC adoption as reported in the literature?

Figure 1: PRISMA flow diagram for SLR (Moher et al., 2009)



The second step, identify the relevant published studies; at this stage, preliminary research is necessary to determine whether there are sufficient studies to conduct an SLR. In addition, to gain a thorough understanding of the subject and to assist in defining the inclusion and exclusion criteria for the founded articles (Tawfik et al., 2019). The Web of Science (WOS) and Scopus were used to conduct the preliminary research. Using the Boolean operators (AND/OR), the following search strategies were used: “Lean construction” AND “Barriers”, “Lean construction” AND “Challenges”, “Lean construction” AND “Benefits”.
The primary results indicated the total articles related to barriers or/challenges, and benefits of LC adoption from WoS (583) and Scopus(909) (see Figure.1).
The third step, assess these studies, by eliminating irrelevant ones, and only focused on the studies that address barriers and challenges associated with LC adoption, and the benefits of LC adoption. On the other hand, studies that were conducted in a language other than English, studies with no full text available, and duplicated or overlapping studies or data were excluded. Fourth step, a spreadsheet was used to examine the findings by assessing the articles' abstracts, methodology, and content. Snowballing, a manual backward and forward technique was also used in the study (Tawfik et al., 2019). In the backward, the researcher used a reference list for each filtered paper to get the old paper, but in the forward, the researcher used the cited of the filtered paper to find a new related paper. This will lead us to the new loop cycle of search, as shown in Figure 1(Moher et al., 2009). Last step, the collected data from articles will be analyzed using a descriptive overview; and then the findings are discussed.

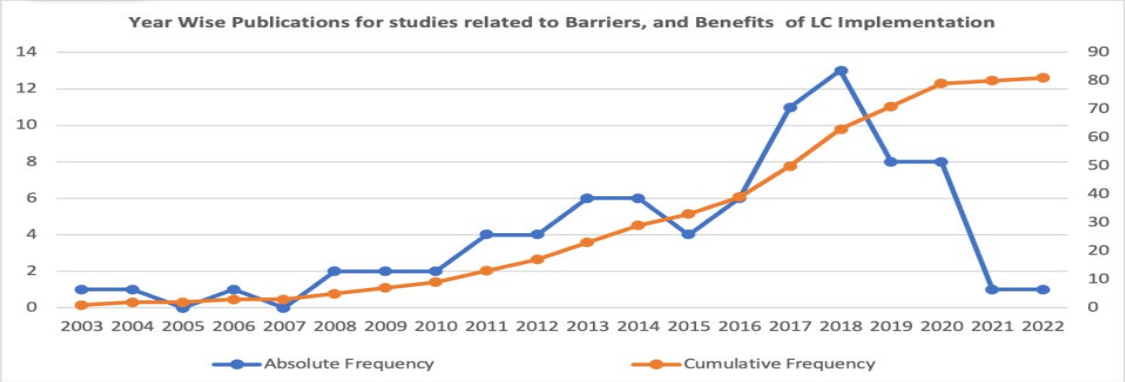
3. Results

As demonstrated above, 81 distinct studies were identified as being compatible with the criteria and contributing to the answer to the proposed RQs. This section shows the descriptive analysis of the literature, defines the organizational methods used to organize the research articles, and identifies areas for future research.

3.1. Sample Characterization

The chronology of the studies is depicted in Figure 2. Even though the subject of LC is a modern type of research and the study of its benefits and barriers has not developed rapidly over the years, the positive year-over-year trend indicates that interest in the topic has increased significantly in the last five years. As a point of reference, the peak of the studies occurred in 2018, accounting for 16% of all published articles.

Figure 2: Year-wise publication



The distribution of the selected studies was in 29 countries (Figure 3). The recent studies concentrate on Nigeria, South Africa, the United States (USA), and the United Kingdom (UK). Moreover, the Percentage of the studies in these countries is 40% of the selected article. On

the other hand, Papers with three or more authors accounted for 47 and 58%, whereas publications with Article type accounted for 53 and 65%. This demonstrates a growing level of collaboration among researchers in this field. Additionally, quantitative and qualitative approaches (questionnaire surveys, interviews) were the most often utilized in the studies that were reviewed (Table 1).

Figure 3: Country of research discusses23 the barriers and benefits of LC

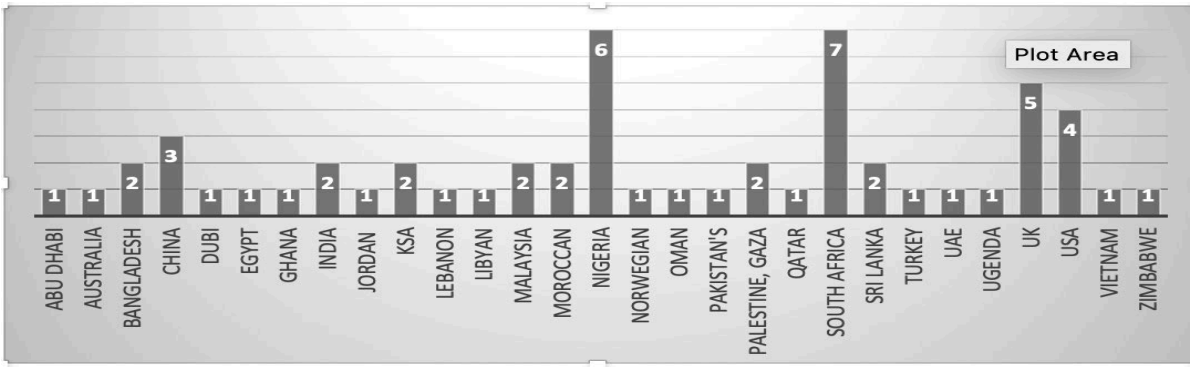


Table 1: Authorship and publication type

Authorship	Number of authors	Article numbers
	1	12
	2	22
	3 and more	47
	SUM	81

Publication type	Type of Publication	Number
	Article	53
	Conference Paper	20
	Thesis	6
	Technical Reports/paper	2
	SUM	81

3.2. Barriers to LC Adoption

Unfortunately, there are numerous barriers to LC adoption. The researchers have diverse perspectives on the subject. The current SLR analyzed the found studies to identify barriers to LC adoption. The narrative summary of these studies was made by grouping them by region and relying on studies that have been done recently. The following section illustrates it.

Africa

Numerous studies have been conducted to determine the major barriers to LC adoption in African countries. In Ghana, according to the results of a questionnaire survey distributed to construction organizations, government policies, insufficient project definitions, insufficient designs, a lack of standardization, and a lack of long-term supplier relationships all contribute to a lack of knowledge and adoption of lean concepts. These factors are classified as managerial, technical, and teamwork problems (Ayarkwa et al., 2012).

LC is one answer to Nigeria's construction industry's requirement to reduce waste and boost productivity; nevertheless, there are seven key obstacles to relying on LC. These barriers relate to skills and knowledge, management, government, human attitude, resources, logistics, and other matters (In addition, another extensive research in the same region found that the most frequent barriers to implementing LC were a lack of lean knowledge and understanding, training, and exposure to the need of adopting lean (Adegbembo et al., 2016). A study conducted in Libya examined nine barriers and discovered that the most significant ones were connected to a lack of skills and expertise, a lack of organizational support, and an inability to monitor how successful the team worked together (Omran & Abdulrahim, 2015).

In South Africa, Aigbavboa et al. (2016) addressed the primary challenges in LC implementation as the extensive usage of unskilled labor, inadequate communication, and human attitude toward change. Moreover, Ramaru (2020) confirmed the aforementioned barriers and added the following: a lack of comprehension of LC concepts, government assistance, and organizational issues. While another study examined the assessment of LC and concluded that attitudes toward LC adoption play a significant impact and that construction industry professionals must improve their attitude toward implementing LC in daily tasks (Oke et al., 2021). More recently, Moyo & Chigara (2021) found 33 barriers to LC adoption in Zimbabwe, categorizing them as integration and performance, human capital management, and quality-related. Additionally, in Morocco, lack of information about the LC is the most frequent barrier, accounting for 85% of the respondents answer rate, followed by unskilled human resources accounting for 67% (Bajjou & Chafi, 2018).

Asia

Numerous studies have been conducted in Western Asia, particularly in Arab countries and Turkey. In early 2016, a survey in Iran uncovered the most significant barriers to LC adoption, including a lack of awareness and expertise, cultural and human resource attitudes, and managerial commitment (Movaghar, 2016). Certain construction projects in the United Arab Emirates (UAE) employ lean concepts, which capture the attention of construction managers. Despite this interest, there is a constraint, and the primary reasons for these constraints were insufficient and difficult design, the changing nature of the construction industry as the economy changes, a lack of coordination between construction participants (contractor involvement), and communication with stakeholders (Kanafani, 2015; Small et al., 2017). Another study in Saudi Arabia (KSA) looked at the types of construction waste and how LC methods can be used at different stages of the project. It sent out 282 questionnaires filled out by construction professionals. The results show that the most important barriers are the organization's culture, lack of training, technical skills, and understanding of lean techniques, and a lack of knowledge of LC approaches (J. Sarhan et al., 2018). The study in Turkey assessed 27 barriers to the LC and categorized them into seven groups related to government, communication, culture, workforce, technical, management and financial (Bayhan et al., 2019). Enshassi et al. (2019) used the same categories to classify 39 barriers to LC adoption in the Gaza Strips, as part of a study aimed at aligning safety improvements with LC implementation. The study's findings indicate that the most significant barriers are a lack of a comprehensive understanding of the concepts, a lack of sufficient support from the government to implement the LC strategy, and insufficient training. In addition, there is a recommendation to provide the construction participants with regular and frequent training in LC principles in order to acquire new approaches for enhancing construction safety. In Qatar, a fuzzy analytical hierarchy process (FAHP) was used to examine 28 hurdles to LC adoption, and the findings indicate that policies, management, and economic groups are the most frequently encountered barriers (Sayed et al., 2019). Following these investigations, similar research on barriers to LC adoption in Jordan, Oman, and Lebanon revealed the same findings and conclusions (Al Balkhy et al., 2021; Albalkhy & Sweis, 2020; Metlej, 2021; Shah et al., 2021).

In Eastern Asia, a little amount of research has been presented, but most of it has been presented in China (Li et al., 2020; Yuan et al., 2020). The major impediments identified in these studies are a lack of a road map for the LC concept, an absence of an LC culture inside the organization, less use of design-construct procurement mode, insufficient knowledge, and multi-layer subcontractors.

Regarding Southern Asia, a study on developing best practices in Malaysia's construction industry identified the LC principles as a best practice for optimizing productivity in the construction industry; and utilized the evaluation system index to discuss the adoption of LC in Klang Valley construction sites. But the most barriers faced in this adoption are related to government inaction, a lack of shared purpose among multiple enterprises, legal and contractual issues, misunderstanding of the lean construction concept, and the tendency of

the construction organization to adopt traditional management concepts rather than productivity and quality management concepts (Ahmed & Wong, 2020). Teaching LC at Indian institutions, according to Antony et al. (2019), is an effective way to raise awareness and overcome common barriers such as a lack of familiarity with lean principles, a preference for traditional methods among practitioners, a mindset issue, and a lack of top-level support. In Bangladesh, 41 hurdles to LC adoption were found, the most important being a lack of understanding regarding LC, a lack of skills and practices, and a lack of financial resources, and sticking to old, established ways and refusing to adopt new one (S. Ahmed et al., 2020). In Sri Lanka (Kariyawasam & Siriwardana, 2021) concluded that while the LC is critical and the construction sector's environment is favorable, certain obstacles must be considered, including lack of awareness, consulting lean costs, inventory costs, unsupported top management, and a lack of resource planning.

Europe, Oceania, South and North America

Many studies presented the LC implementation/adoption in the UK. One of these studies discusses how LC is used to manage and assist in evaluating and adding value to construction industry waste management. Despite the benefits of LC, there are limitations to its use, which are related to several barriers to its sustainable implementation. These barriers fall into the following categories: managerial, financial, educational, governmental, technical, and human-related issues (Bashir et al., 2015). On the other hand, Tezel et al. (2018) presented a study evaluating LC adoption in highway construction by examining 16 barriers, 20 LC techniques, and seven motivations. According to the survey analysis, the most significant barriers were a lack of understanding of LC concepts, a lack of awareness of the value and benefits of LC, insufficient know-how, and employee resistance. There are six major impediments to implementing the Green LC paradigm in Australia: economic, procurement, regulatory, technical, cultural, and organizational. These barriers were identified through 18 interviews with construction industry professionals (Hussein & Palaneeswaran, 2018). In Norway, many case studies found that a lack of LC expertise, clearly stated objectives, and top management participation all contributed to the LC adoption (Torp et al., 2018). The USA accounted for a sizable portion of the research that utilized LC. Authors, such as Demirkesen et al. (2019) and Martinez et al. (2019) examined barriers to LC adoption and found that the primary important challenges in the USA construction sector are lack of top management support and unpreparedness for LC procedures. From recent studies in the aforementioned SLR, we can group the barriers to LC adoption into seven primary classifications: [1] skill and knowledge (SKB), [2] management (MB), [3] government (GB), [4] attitude (AB), [5] resource (RB), [6] technical (TB), and [7] financial and other's barriers(FOB) (Table 2).

Table 2: Barriers to LC adoption

	Barriers ID	Definition	Studies	No.
Skill and Knowledge	SKB1	Lack of awareness of LC concepts and tools	(Adegbembo et al., 2016; Al Balkhy et al., 2021; Albalkhy & Sweis, 2020; Ayarkwa et al., 2012; Bajjou & Chafi, 2018; Bashir et al., 2015; Enshassi et al., 2019; Li et al., 2020; Metlej, 2021; Movaghar, 2016; Olamilokun, 2015; Ramaru, 2020; Shah et al., 2021; Sholanke et al., 2019; Yuan et al., 2020; Tezel et al. 2018; Demirkesen et al., 2019,Martinez et al., 2019)	19
	SKB2	Lack of Standardization	(Al Balkhy et al., 2021; Albalkhy & Sweis, 2020; Ayarkwa et al., 2012; Metlej, 2021; Olamilokun, 2015; Shah et al., 2021; Sholanke et al., 2019; Demirkesen et al., 2019, Martinez et al., 2019)	10
	SKB3	Poor technical skills and knowledge	(Adegbembo et al., 2016; S. Ahmed et al., 2020; Al Balkhy et al., 2021; Albalkhy & Sweis, 2020; Ayarkwa et al., 2012; Bajjou & Chafi, 2018; Bashir et al., 2015; Li et al., 2020; Metlej, 2021; Movaghar, 2016; Olamilokun, 2015; Omran & Abdulrahim, 2015; J.	18

			Sarhan et al., 2018; Shah et al., 2021; Sholanke et al., 2019; Yuan et al., 2020; Tezel et al. 2018; Torp et al., 2018)	
	SKB4	Lack of training	(Adegbembo et al., 2016; Al Balkhy et al., 2021; Albalkhy & Sweis, 2020; Bajjou & Chafi, 2018; Enshassi et al., 2019; Metlej, 2021; Olamilokun, 2015; Omran & Abdulrahim, 2015; Shah et al., 2021; Sholanke et al., 2019)	10
	SKB5	Difficulty to understand new technology	(S. Ahmed et al., 2020; Al Balkhy et al., 2021; Albalkhy & Sweis, 2020; Antony et al., 2019; Enshassi et al., 2019; Metlej, 2021; Olamilokun, 2015; Ramaru, 2020; J. Sarhan et al., 2018; Shah et al., 2021; Sholanke et al., 2019)	11
Management	MB1	Contractors and specialists are rarely involved in the design phase.	(Al Balkhy et al., 2021; Albalkhy & Sweis, 2020; Metlej, 2021; Movaghar, 2016; Olamilokun, 2015; Shah et al., 2021; Sholanke et al., 2019)	7
	MB2	Inadequate pre-planning	(Al Balkhy et al., 2021; Albalkhy & Sweis, 2020; Ayarkwa et al., 2012; Metlej, 2021; Movaghar, 2016; Olamilokun, 2015; Shah et al., 2021; Sholanke et al., 2019)	8
	MB3	Slow decision making	(Movaghar, 2016; Moyo & Chigara, 2021; Olamilokun, 2015; Sholanke et al., 2019; Al Balkhy et al., 2021; Albalkhy & Sweis, 2020; Metlej, 2021; Shah et al., 2021)	8
	MB4	Lack of supply chain integration	(Movaghar, 2016; Olamilokun, 2015; Sholanke et al., 2019; Al Balkhy et al., 2021; Albalkhy & Sweis, 2020; Metlej, 2021; Shah et al., 2021)	7
	MB5	Poor communication and coordination system	(Movaghar, 2016; Moyo & Chigara, 2021; Olamilokun, 2015; Omran & Abdulrahim, 2015; Ramaru, 2020; Sholanke et al., 2019; Al Balkhy et al., 2021; Albalkhy & Sweis, 2020; Metlej, 2021; Shah et al., 2021)	10
	MB6	Depends on many subcontractors	(Li et al., 2020; Olamilokun, 2015; Sholanke et al., 2019; Yuan et al., 2020)	4
	MB7	lack of long-term supplier relationships	(Ayarkwa et al., 2012; Movaghar, 2016; Olamilokun, 2015; Sholanke et al., 2019; Al Balkhy et al., 2021; Albalkhy & Sweis, 2020; Metlej, 2021; Shah et al., 2021)	8
Government	GB1	Lack of assistance from the government.	(Bashir et al., 2015; Enshassi et al., 2019; Olamilokun, 2015; Ramaru, 2020; Sholanke et al., 2019)	5
	GB2	The policies of the government are inconsistent.	(Ahmed & Wong, 2020; Ayarkwa et al., 2012; Bashir et al., 2015; Olamilokun, 2015; Ramaru, 2020; Sayed et al., 2019; Sholanke et al., 2019)	7
Attitude	AB1	Lack of long-term commitment to innovation and change	(Adegbembo et al., 2016; Li et al., 2020; Moyo & Chigara, 2021; Oke et al., 2021; Olamilokun, 2015; Ramaru, 2020; Sholanke et al., 2019; Yuan et al., 2020)	9
	AB2	Lack of support from top management	(Adegbembo et al., 2016; Antony et al., 2019; Enshassi et al., 2019; Kariyawasam & Siriwardana, 2021; Movaghar, 2016; Moyo & Chigara, 2021; Oke et al., 2021; Olamilokun, 2015; Omran & Abdulrahim, 2015; Ramaru, 2020; Sayed et al., 2019; Sholanke et al., 2019; Hussein & Palaneeswaran, 2018; Torp et al., 2018; Demirkesen et al., 2019, Martinez et al., 2019)	18
	AB3	Stick to the old ways and refuse to use new technology.	(Antony et al., 2019; Movaghar, 2016; Moyo & Chigara, 2021; Oke et al., 2021; Olamilokun, 2015; Ramaru, 2020; Sholanke et al., 2019; Tezel et al. 2018)	9

Resource	RB1	Inadequacy of equipment	(Aigbavboa et al., 2016; Bajjou & Chafi, 2018; Kariyawasam & Siriwardana, 2021; Olamilokun, 2015; Sholanke et al., 2019)	5
	RB2	Scarcity of materials	(Aigbavboa et al., 2016; Bajjou & Chafi, 2018; Bayhan et al., 2019; Kariyawasam & Siriwardana, 2021; Olamilokun, 2015; Ramaru, 2020; Sholanke et al., 2019)	7
Technical	TB1	Incomplete design	(Ayarkwa et al., 2012; Bashir et al., 2015; Bayhan et al., 2019; Kanafani, 2015; Li et al., 2020; Olamilokun, 2015; Sholanke et al., 2019; Small et al., 2017; Yuan et al., 2020)	9
	TB2	Lack of technological advancement	(Bashir et al., 2015; Moyo & Chigara, 2021; Olamilokun, 2015; Ramaru, 2020; Sholanke et al., 2019)	5
	TB3	poor project phase definition	(Ayarkwa et al., 2012; Bashir et al., 2015; Olamilokun, 2015; Sholanke et al., 2019)	4
Financial and others	FOB1	Inflation	(Kanafani, 2015; Kariyawasam & Siriwardana, 2021; Olamilokun, 2015; Sayed et al., 2019; Sholanke et al., 2019; Small et al., 2017; Hussein & Palaneeswaran, 2018)	7
	FOB2	The lack of funding in comparison to the implementation costs	(Bashir et al., 2015; Kariyawasam & Siriwardana, 2021; Olamilokun, 2015; Sholanke et al., 2019)	4
	FOB3	Difficulty nature of construction industry.	(Kanafani, 2015; Olamilokun, 2015; Sholanke et al., 2019; Small et al., 2017; Al Balkhy et al., 2021; Albalkhy & Sweis, 2020; Metlej, 2021; Shah et al., 2021)	8

3.3. Benefits of LC implementation

According to common perception, no one embraces new technology or concepts until it improves task organization, and accomplish the golden triangle advantages of cost, time, and quality. Numerous studies have been conducted to demonstrate the benefits of LC adoption and persuade decision-makers to do so. An empirical study conducted in the UK construction sector discovered that the primary benefits of LC adoption were an enhanced corporate image, greater productivity, waste reduction, and energy consumption reduction (Ogunbiyi et al., 2014). Following the global trend, Memon et al.(2018) conducted a study to determine the feasibility of adopting lean construction techniques in Pakistan, the results indicated that the advantages of lean construction are its capacity to eliminate waste, boost customer satisfaction, improve communication, improve visual monitoring, and guarantee that staff is appropriately organized to do their assigned responsibilities. In Palestine, many construction companies are reluctant to implement new management practices, yet the benefits of LC in reducing waste and increasing project value are undeniable. Furthermore, the findings of study carried out by Enshassi et al. (2019) highlighted that LC has a significant impact on building project safety. Following an analysis of a survey given to KSA's construction sector, the most significant advantages of LC adoption are: customer satisfaction, enhancement of quality, an increase in production, and a decrease in construction time (J. G. Sarhan et al., 2017).
Shah and his colleagues recently did a study of the Oman construction industry. According to the Relative Important Index (RII) value, adoption of LC will lead to more environmentally-friendly projects, cost savings, and better planning and control (Shah et al., 2021). Numerous studies conducted in South Africa, Nigeria, and Bangladesh to discuss the LC benefits (Akinradewo et al., 2018; Maradzano et al., 2019; Adegbembo et al., 2016; S. Ahmed et al., 2020; Shaqour, 2022) and concluded that the most significant benefits include waste reduction, improved material management on-site, enhance project life cycle cost, client satisfaction, achieving the highest level of project coordination, increased safety, and improved risk management.

After examining a few articles, focusing on the most recent (S. Ahmed et al., 2020; Memon et al., 2018; Shah et al., 2021; Shaqour, 2022), The benefits of lean in the construction industry are grouped into three categories: Economic, Environmental, Social benefits. The benefits identified according to this classification are depicted in Table 3.

Table 3. Benefits of LC adoption

Economic (79%)	Environmental (64%)	Social (61%)
1. Improve planning and control all process 2. Reduce time 3. High risk expectation 4. Minimize rework 5. Labor cost reduction 6. Improve life cycle cost	1. Control the materials storage 2. Safety improvement 3. Waste reduction 4. Reduction of energy consumptions	1. Enhancing transparency 2. Improve communication between stakeholders 3. Customer satisfaction 4. Employee satisfaction 5. Reduce conflicts 6. Increase team work 7. Continue Improvement 8. Improve decision making

4. Conclusion

LC has been demonstrated to be an effective and sustainable technique. Depending on the approach taken in adopting LC, many studies using a variety of methods were conducted to debate and emphasize these new practices. This study was able to address the questions that had been asked in the beginning by doing the SLR to evaluate and review the previous studies. First, the study presented here categorized previous studies by namely, country, and year. Second, to address RQ1, RQ2, numerous research was given to describe the barriers to and advantages of LC adoption. Seven areas of barriers to LC were discovered in SLR: skills and knowledge, management, government, technical, resource, and attitude, as well as financial and other barriers. The most often highlighted barriers in previous researches are a lack of top management support, lack of awareness, sticking with the traditional way, and lack of knowledge about LC concepts. On the other hand, the number of research discussing the benefits of LC in itself, without mentioning LC barriers or any other technique, was quite little. But the most highlighted benefits were classified into three groups: economic, environment, and social. This study will assist construction professionals in engaging and accepting LC by aligning their objectives with the advantages of the LC and avoiding the barriers to adopting it. On the other hand, this study may serve as the basis for future researchers.

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Comunicación alineada con los Objetivos de Desarrollo Sostenible