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KEY PARAMETERS OF LEAN CONSTRUCTION MATURITY: A DELPHI STUDY

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ABSTRACT

Lean construction has emerged as a transformative force, seeking to enhance efficiency, minimise waste, and streamline project delivery processes. Despite global recognition and adoption, lean construction maturation exhibits variances across diverse contexts. In Sri Lanka, lean construction remains at an early stage of development. Given the nation's challenges in the construction sector and evolving project management methodologies, Sri Lanka offers a distinctive setting for exploring the maturity of lean construction principles. However, insufficient methods of investigating lean construction maturity in the Sri Lankan context have led to limited adoption of lean practices within the construction sector. Therefore, this study aims to investigate the relevant parameters for assessing lean construction maturity in the context of Sri Lanka. Adopting an interpretive stance, the study employed a qualitative research approach with semi-structured interviews using the Delphi technique. A total of 25 lean construction experts were selected through purposive sampling and 73 interviews were conducted in three Delphi rounds. Findings revealed 18 key lean construction parameters and definitions were developed conforming to Sri Lankan context. The study provides actionable insights for practitioners including identifying relevant lean practices and guidance on lean implementation, enabling them to enhance practices, improve efficiency, reduce waste, and make informed decisions through tailored initiatives and strategies. This study enhances the global understanding of lean construction maturity by identifying lean construction parameters conforming to Sri Lanka, contributing to the existing theory and filling a literature gap.

Keywords: *Defining Lean Construction Parameters; Lean Construction; Lean Construction Maturity.*

1. INTRODUCTION

The construction sector has faced prolonged problems in enhancing productivity and efficiency (Tariq & Gardezi, 2023). The construction industry consistently struggles with numerous challenges, including excessive wastage, recurrent delays, budget overruns, and quality control issues (Nowotarski et al., 2016). In recent years, lean construction has created a paradigm shift in the construction sector, aimed at maximising efficiency, reducing waste, and optimising project delivery processes (Aslam et al., 2024). While

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lean construction principles have been widely acknowledged and adopted globally, the degree of lean construction maturity varies across different countries (Arditi et al., 2021). Especially in the case of Sri Lanka, lean construction is still in its early stages (Ranadewa et al., 2021). Lean construction maturity helps organisations assess the lean journey and obtain a realistic understanding of the status (Likita et al., 2024). Reaching higher lean maturity allows optimising project processes, eliminating waste, enhancing productivity, stakeholder collaboration, and adaptability to change. This will position organisations for sustained success in a competitive marketplace (Agrawal et al., 2024).

Determinants of lean construction maturity were investigated in several countries, i.e., the UK (Nesensohn et al., 2015), Brazil (Rodegheri & Serra, 2020), Saudi Arabia (Sarhan et al., 2020), Ireland (Highways Agency, 2012), Germany (Johansen and Walter, 2007). These studies provide a basic understanding of fundamental lean construction parameters; however, they are developed in specific countries. Therefore, it raises concerns regarding the applicability to Sri Lanka. Moreover, it is clear that the lack of research on lean construction and the lack of means to assess lean construction maturity in the Sri Lankan context has resulted in less lean implementation in the construction sector (Ranadewa et al., 2019). Consequently, there is a clear need to investigate Sri Lankan-specific lean construction parameters to enhance the implementation of lean construction in Sri Lanka. Therefore, this research is aimed at investigating the lean construction parameters specific to Sri Lanka. In the process, research objectives were recognised as identifying key parameters of lean construction maturity relevant to the Sri Lankan context and defining key parameters conforming to the Sri Lankan context. Achieving this aim will bridge the theoretical gap and provide insights for stakeholders to effectively evaluate and enhance lean construction maturity in Sri Lanka. Sri Lanka, with its challenges in the construction sector and evolving project management practices, presents a unique environment for examining the development of lean construction principles. This will ultimately contribute to the advancement and sustainability of the construction sector. Further, the study can be used as a guide for countries with similar socio-economic conditions.

The paper starts with an introduction to the topic and research gap followed by a comprehensive literature review on key lean construction parameters. The methodology section outlines the research process, and the findings are presented with a discussion. Subsequently, research implications are provided followed by future research areas.

2. LITERATURE REVIEW

2.1 LEAN MATURITY AND LEAN CONSTRUCTION MATURITY

Lean maturity refers to the degree of skill and efficiency with which an organisation applies lean principles and methods (Hamza-Khan et al., 2024). Lean maturity involves a dynamic journey of organisational growth where the focus is on continuous learning and the seamless integration of new knowledge into everyday operations (Zanon et al., 2021). Lean construction maturity refers to the level of implementation and integration of lean principles and practices within a construction organisation or industry (Jørgensen et al., 2007). It describes how effectively lean concepts such as minimising waste, optimising processes, improving productivity, and enhancing value are adopted and utilised throughout the project lifecycle (Jayanetti et al., 2023). Maturity models play a key role in evaluating organisational maturity. Such models establish a systematic process for achieving excellence, serving as valuable tools for examining and assessing the

current state of a process, organisation, or phenomenon (Galichet et al., 2024). MMs help reduce the uncertainties associated with adopting new principles by offering clear assessment tools (Sukrat & Leeraphong, 2023). Lean construction maturity assessment provides organisations with insights into the current status of lean construction implementation, key barriers, and strategies on how to reach higher lean construction maturity (Rodegheri & Serra, 2020).

2.2 KEY PARAMETERS OF LEAN CONSTRUCTION MATURITY

Lean construction parameters outline the broader concept of lean construction principles (Koskela et al., 2007). In describing lean construction maturity, many authors have relied on various lean construction parameters to minimise all kinds of waste and enhance overall construction productivity (Nesensohn et al., 2015). Through a comprehensive literature review, authors identified the most acknowledged parameters of lean construction that are relevant in determining lean construction maturity as shown in Table 1.

Table 1: Key parameters of lean construction maturity

Lean construction parameters	Source of reference																	
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**
Reduction of waste	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Continuous improvement	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Deliver exact customer value	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Reduction of non-value-adding activities	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Respect	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Quality management	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Optimising the whole	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	
Transparency in processes	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	
Standardisation	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓
Integration of supply chain	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓		✓
Leadership	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓			✓	✓	✓
Increase output flexibility	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓				
Minimise uniqueness	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓						

Sources: [A] - Koskela (1992) and Koskela et al. (2002); [B] Ballard (2000) and Ballard et al. (2007); [C] Howell (1999); [D] Tommeline (1998) and Tommeleine (2015); [E] Lean Construction Institute (2023); [F] Tzortzopoulos et al. (2020) and Tzortzopoulos & Formoso (1999); [G] Womack & Jones (1997) and Jones & Womack (2016); [H] Nesensohn et al. (2015) and Nesensohn (2014); [I] Rodegheri & Serra (2020); [J] Hofacker et al. (2008); [K] Carvalho & Scheer (2017); [L] Lean Construction Institute (2016); [M] Arantes (2010); [N] Johansen & Walter (2007); [O] Cookson & Stirk (2019); [P] Sarhan et al. (2020); [Q] Rashidian et al. (2022); [R] Nightingale et al. (2001)

Among the parameters of lean construction, waste elimination, creation and delivery of customer value, continuous improvement, quality management, reduction of non-value-adding activities, and respect for people are noted to be at the forefront. This is

understandable since the core of lean construction is the minimisation of all kinds of waste (Koskela et al., 2007). Customer satisfaction and delivering exact customer value is considered a core principle of lean construction (Ballard & Howell, 1998). Upon examining the identified key parameters, it becomes apparent that elements such as leadership, information dissemination, and transparency are prioritised. This extends beyond the construction phase to encompass broader organisational considerations. These factors contribute to a more comprehensive understanding and management of organisational dynamics (Rodegheri & Serra, 2020). Moreover, these lean construction parameters provide a holistic determination of an entity's maturity in lean construction practices.

2.3 LEAN CONSTRUCTION MATURITY IN SRI LANKA

Focusing more on the Sri Lankan construction sector, lean construction is still in the early stages (Ranadewa et al., 2019). Similarly, several scholars claim that lean construction is being practised modestly amongst construction organisations in Sri Lanka, nevertheless, many of those organisations are not certain about creating a lasting lean culture due to the inability to assess lean construction maturity. The critical issue faced by many construction firms is the uncertainty of implementing lean since there is no strategic road map on where it would lead the organisations (Waduwawala et al., 2019). This uncertainty has led organisations to move away from employing lean in the Sri Lankan context. Investigating lean construction maturity in the case of Sri Lanka, there is evidence of literature on maturity, however, not specifically for the construction industry. Maturity in the third-party logistics industry (Gamini et al., 2019), maturity assessment garment industry (Kulasooriya & Chalapathi, 2014), maturity evaluation in the banking sector (Bandara et al., 2019), Building Information Modeling maturity (Jayasena & Wedikkara, 2013) are noteworthy studies on maturity however not directed at lean construction. Therefore, the literature clearly indicates a clear gap in investigating lean construction maturity in the context of Sri Lanka.

3. METHODOLOGY

A qualitative methodology proves beneficial when the aim is to explore respondents' perspectives, knowledge, and expertise (Yin, 2016). Qualitative research offers a means to investigate deeply into a phenomenon and uncover insights to address research questions (Saunders et al., 2009). Given the study's main aim is to investigate the most relevant parameters for Lean construction maturity in the context of Sri Lanka and define them to suit Sri Lankan context, a qualitative approach is chosen. In formulating the research question to achieve the aim, methodologies such as PICOS (Population, Intervention, Comparison, Outcomes, Setting) and CIMO (Context, Intervention, Mechanisms, Outcomes) play a crucial role (Methley et al., 2014). Given the research's emphasis on management and policy, the authors opted for the CIMO approach, and the research question was identified as "What are the essential parameters to successfully determine lean construction maturity in Sri Lanka?"

In answering this research question, the authors adopted the qualitative Delphi method using semi-structured interviews to collect expert opinions. In contemporary research, the Delphi technique allows for an in-depth exploration of a phenomenon by searching for knowledge where the number of experts is limited (Keeney et al., 2011). Since there is a scarcity in Sri Lanka of lean construction experts (Ranadewa et al., 2019), a qualitative

Delphi study would provide a practical approach to gathering rich and meaningful insights into how lean construction maturity is understood in the context of Sri Lanka. Moreover, the Delphi method is a systematic interactive technique involving two or more rounds of structured surveys or interviews, which can be used to obtain the views of an independent expert panel and provide in-built validation (Aghimien et al., 2020). Scholars have noted the importance of the Delphi method in validating collected data, with a consensus level of 75% being commonly accepted (Keeney et al., 2006). To achieve this level of agreement, three rounds of Delphi were conducted, as shown in Table 2 (Mansour et al., 2022). In the Delphi method, the sample is purposively selected strictly considering pre-defined criteria of lean construction maturity which remarkably increases the findings' accuracy compared to data gathered from unstructured interacting groups (Olsen et al., 2021). The selection of experts is crucial in the Delphi process, necessitating a thorough and comprehensive criterion for their selection (Skulmoski et al., 2007). Table 2 explains the selection criteria adopted for selecting lean construction experts. In selecting the experts, compulsory qualifications ensured that experts are equipped with the experience and competency in both lean construction and built environment. Additional qualifications ensure the knowledge of the experts. The sample size was limited to 25 since it reached saturation (Patton, 2002).

Table 2: Delphi rounds and expert's profile

Delphi Round (R)	Phase (P)	Key Objectives
Delphi round 1	Round I Phase 1 (R1P1)	Identify parameters of Lean construction maturity
Delphi round 2	Round 2 Phase 1 (R2P1)	Identify key parameters of lean construction maturity relevant in the Sri Lankan context
	Round 2 Phase 2 (R2P2)	Recognize important elements for defining Key parameters of lean construction maturity relevant in the Sri Lankan context
Delphi round 3	Round 3 Phase 1 (R3P1)	Define key parameters of lean construction maturity conforming to the Sri Lankan context

	Compulsory (Must satisfy at least one from each)				Additional Qualifications (Must satisfy at least 3)					Participation		
	A		B									
Expert Code	5+ experience in lean construction job role	3+ academic experience in lean construction	10+ experience in built environment	10+ academic experience in built environment	Graduated in built environment discipline	Professional affiliation to Lean-related institution	Member of a professional institution in built environment	Master's qualification in built-environment or lean	2+ indexed publications	Delphi R1 25	Delphi R2 24	Delphi R3 24
E1	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
E2	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
E3	✓		✓		✓	✓	✓	✓		✓	✓	✓
E4	✓		✓		✓		✓	✓		✓	✓	✓
E5	✓		✓		✓		✓	✓		✓	✓	✓
E6	✓		✓		✓		✓	✓		✓	✓	✓
E7	✓		✓		✓		✓	✓		✓	✓	✓
E8	✓		✓		✓	✓	✓	✓		✓	✓	✓
E9	✓		✓		✓		✓	✓		✓	✓	✓
E10	✓		✓		✓		✓	✓		✓	✓	✓
E11	✓		✓		✓		✓	✓		✓	✓	✓
E12	✓		✓		✓		✓	✓		✓	✓	✓
E13	✓		✓		✓		✓	✓		✓	✓	✓
E14	✓		✓		✓		✓	✓		✓	✓	✓
E15	✓		✓		✓		✓	✓		✓	✓	✓
E16	✓		✓		✓		✓	✓		✓	✓	✓
E17	✓		✓		✓			✓		✓	✓	✓
E18	✓		✓		✓			✓		✓	✓	✓
E19		✓		✓	✓			✓	✓	✓	✓	✓
E20		✓		✓	✓			✓	✓	✓	✓	✓
E21		✓		✓	✓			✓	✓	✓	✓	✓
E22		✓		✓	✓			✓	✓	✓	✓	✓
E23		✓		✓	✓			✓	✓	✓	✓	✓
E24		✓		✓	✓			✓	✓	✓	✓	✓
E25		✓		✓	✓			✓	✓	✓		

4. FINDINGS AND ANALYSIS

4.1 KEY PARAMETERS OF LEAN CONSTRUCTION MATURITY RELEVANT TO THE SRI LANKAN CONTEXT (R1P1 AND R2P1)

This section presents the findings of R1P1 and R2P1. In R1P1 experts were tasked with identifying lean construction parameters that constitute lean construction maturity in a general perspective without confining to Sri Lanka. Experts validated twelve parameters identified from the literature and rejected one parameter. Moreover, the authors added one more parameter as well. Consequently, twelve parameters were brought forward to R2P1. In R2P1 experts were requested to identify key parameters relevant specifically for the Sri Lankan context. In the process, authors validated twelve parameters and added six new parameters (In bold text), considering the context of Sri Lanka bringing the total number of parameters to 18. Experts rejected the parameter '*Minimise uniqueness'* as not relevant for Sri Lanka. Table 3 shows the corroborated parameters.

In identifying the key parameters of lean construction maturity in the Sri Lankan construction context, all the authors unanimously corroborated the most visible lean construction parameters such as waste reduction, continuous improvement, delivering exact customer value, reduction of non-value-adding activities, respect for all, quality management, and optimising the whole. E2 added "*well especially in these circumstances of Sri Lankan construction, it is the need of the hour that we really try to reduce all the types of waste. I mean we all talk about this but are we doing enough? So lean construction really makes you think to identify what are the types of waste, how to proactively identify them and how to treat them proactively*". Emphasising the value of continuous improvement E10 mentioned that "*continuous improvement is something that we are lacking in our industry but should be a must. We always rely on conventional methods thinking that they are the best, but we need to think ahead, we need to keep on trying, we need to keep advancing and we need to find room for improvement continuously.* Delivering exact customer value was considered a highly relevant parameter for Sri Lankan lean construction maturity, where all the experts unanimously corroborated. E1 stated, *"As a core lean principle identifying the exact thing customer needs is really important to excel in this industry. It has to be no more no less strategy*". Moving further experts validate the parameter of leadership to be highly relevant in the context of Sri Lanka. Confirming the relevancy of transparency E5 added "*I think transparency is very important since it provides an idea of trustworthiness, and it clears all unnecessary bottlenecks*". Considering the aspect of minimising unique content, authors rejected the parameter as not relevant for Sri Lanka due to several key reasons such as "*diverse project requirements", "localised techniques" and "cultural architectural diversity*". Experts added value engineering as a new aspect stating as mentioned by E25, "*well in many cases we need to come up with novel solutions to give the best solution for our client so that value engineering is a big part of it*".

4.2 DEFINITIONS OF KEY PARAMETERS OF LEAN CONSTRUCTION MATURITY IN THE SRI LANKAN CONTEXT (R2P1, R2P2 AND R3P1)

This section presents to finalised list of parameters and their definitions according to experts' views. In R2P2 experts were asked to recognise important elements for defining key parameters identified in R2P1. Important elements corroborated with more than 75% consensus were taken to the third round. In R3P1 the experts were tasked with developing

definitions for the key parameters identified in R2P1 using important parameters identified in R2P2. Table 3 reveals definitions of Key parameters of lean construction maturity in the Sri Lankan context.

Table 3: Key parameters and definitions of lean construction maturity

Parameter	Definition
Reduction of waste	Implementing strategies **to proactively identify wastes** of all kinds, set **systematic measures** to reduce wastes of **all formats**, ensure optimal resource utilisation and embed a **zero-waste culture**.
Continuous improvement	Cultivating a **culture of development and innovation**, where stakeholders **consistently seek** to foster an environment of **continuous learning and improvement**, drawing from **traditional practices and adapting them with modern techniques.**
Deliver exact customer value	Ensuring projects are accurately planned and executed to meet the **precise needs and expectations of clients**, prioritising **customer satisfaction**, and understanding **cultural nuances** and client preferences unique to Sri Lanka's diverse communities.
Reduction of non-value-adding activities	**Pre-emptively identifying** and **removing non-value-adding activities**, **optimizing workflows** and resources to reduce waste, and ensuring **alignment with cultural, social, and environmental values**.
Respect for all	Nurturing a work environment that **values diversity**, promotes **inclusivity**, and treats all stakeholders with **dignity and respect**, regardless of role, background, or position within the industry and ensuring **fair treatment** and **equal opportunities**.
Quality management	**Rigorous quality assurance** and **control measures** to meet standards and regulations, ensuring safety, durability, and high quality by maintaining **stringent quality standards**.
Optimizing the whole	Considering the **interdependence of stakeholders**, **optimising the entire value chain** for maximum efficiency and success by **blending traditional practices with modern methods** to enhance outcomes.
Transparency in processes	Promotes **transparency, honesty, and accountability** across all facets emphasising **open communication** to cultivate trust among stakeholders and encourage collaboration.
Standardisation	Establishing **standardised procedures**, specifications, and **best practices** in the construction industry **adapting global best practices** to **suit local contexts** and **collaborating with industry stakeholders.**
Integration of supply chain	Collaborating closely with all stakeholders fostering **long-term partnerships** with **local suppliers** and **subcontractors** to build a **resilient** and **responsive** supply chain **network**.
Leadership	Providing **strategic direction**, **inspiring and empowering teams** to achieve **common goals**, driving **positive change** within the industry **empowering teams**, and fostering a **culture of innovation and collaboration** to drive industry progress.
Increase output flexibility	Enhancing ability to **adapt to changing requirements**, and **market demands** by fostering **agility** and **resilience** to accommodate **unforeseen challenges** and capitalize on emerging opportunities within the dynamic Sri Lankan construction landscape.
Value engineering	Applying **systematic analysis** and **creative problem-solving** techniques to maximize value while minimizing costs, integrating **local expertise** with **global best practices** to identify cost-effective solutions that **optimize project value**.

Parameter	Definition
Change management	**Proactively manage changes** by identifying **change agents**, empowering them to **drive change**, **managing resistance** through **transparent communication**, and **providing training and support** for successful implementation within the dynamic construction sector.
Technology adoption	Embracing **innovative technologies** to enhance efficiency, by utilizing **emerging technologies** and digital **collaboration platforms** to **optimize project delivery** and **enhance stakeholder engagement.**
Capacity building	Investing in **training, education**, and **skill development** initiatives to **strengthen** the **competencies** of the workforce, and **fill skills gaps** by collaborating with **educational institutions**, **industry associations**, and **government agencies**.
Policy enhancement	Adhering to regulations and industry standards while **actively advocating for necessary policy reforms** by recognizing that **traditional policies may need revision** to foster **innovation**, and to better meet **lean construction objectives**.
Ethical business practices	Upholding ethical standards and principles of **integrity, honesty,** and **fairness** in all aspects to build **trust** and **credibility** within the industry and society.

According to expert perspectives, these definitions aim to capture the reflective essence of lean principles, shifting from conventional approaches to enhancing construction activities by promoting a proactive stance. As stated by experts, these definitions provide an accurate guideline for industry practitioners to better understand how these lean concepts can be utilised effectively to achieve greater project outcomes.

5. DISCUSSION

In identifying parameters relevant to determining lean construction maturity in Sri Lanka, experts' views indicated a positive alignment with the literature. Core lean principles such as waste elimination, respect for everyone, continuous improvement, quality management, optimising the whole and delivering exact customer value, were overwhelmingly validated by experts as suitable for Sri Lankan context. These factors were evident in the existing studies on lean construction maturity and existing maturity models as well (Koskela et al., 2007; Nesensohn et al., 2015). The main reason for this alignment is the fundamental principles of Lean construction, which ensure that the foundational concepts and practices are universally applicable. However, the practical elements need more country-specific validation to account for local conditions and contexts.

Eventhough minimising unique content is accepted as a lean parameter by scholars (Howell, 2014), experts contend that, currently, this principle may not be applicable to the Sri Lankan construction context. Expert's argument is based on several factors including diverse project requirements, localised construction techniques, and the rich cultural architectural diversity prevalent in Sri Lanka. These aspects necessitate a unique approach that integrates local practices and respects cultural differences. Therefore, while Lean principles advocate for minimising variations, the unique characteristics of Sri Lanka's construction landscape call for a balance between standardised Lean practices and adaptable, context-specific approaches. These same factors are noted by several scholars as characteristics unique to the construction sector (Li et al., 2017), supporting the argument made by the experts.

Experts newly suggested and defined six key parameters i.e., (i) value engineering, (ii) change management, (iii) technology adoption, (iv) capacity building, (v) policy enhancement, and (vi) ethical business practices, considering the preliminary level of lean construction in the Sri Lankan context. Among the elements employed to develop definitions of lean construction parameters, several elements identified by experts were visible in the literature as well. Proactive waste identification (Koskela et al., 2002), waste minimisation (Perera & Shandraseharan, 2023), creating a continuous improvement culture (LCI, 2023), identifying precise customer needs (Nesensohn et al.,2015), quality assurance and control (Arditi et al., 2021), optimising workflows are key elements and terminologies which were directly adopted by authors to define parameters. Moreover, strategic direction, inspiring and empowering teams (Sadikoglu et al., 2023), optimising the entire value chain (Ballard & Howell, 1998), and encouraging collaboration (Arditi et al., 2021) are key themes found in the literature that were instrumental in defining key lean construction parameters through expert insights.

Considering the definitions developed for key lean construction parameters, experts underscored several key themes. Considering parameters such as waste elimination and reducing non-value-adding activities, experts emphasised that proactively seeking ways to identify points of waste occurrence in Sri Lankan construction projects is imperative. This idea is well-acknowledged by scholars as well (LCI, 2023). Customer satisfaction entailed various key aspects such as understanding the exact needs of customers and customer satisfaction, which were well accepted by authors and in previous literature (Bernstein & Jones, 2013). Experts added the factor of considering the diverse cultural values due to the country's multicultural status. Defining the lean construction parameter of optimising the whole, experts underlined the value of optimising the entire value chain which was directly corroborated in the literature as well (Koskela et al., 2007). However, the authors suggested the idea of blending traditional practices with modern methods, highlighting some of the unique Sri Lankan construction practices. In defining transparency in the Sri Lankan context, the ideas of experts directly matched with literature highlighting the need for transparency, honesty, and accountability (Herrera et al., 2019). Standardisation was defined by experts through concepts of standardised procedures, specifications and best practices quite similar to findings highlighted by scholars (Cookson & Stirk, 2019). Adapting to changing requirements, and fostering agility and resilience are several key points emphasised in defining increasing output flexibility by Sri Lankan experts which closely aligned with ideas made by several authors (Arditi et al., 2021).

5.1 IMPLICATIONS OF THE RESEARCH

5.1.1 Theoretical Contribution

The study contributes to the global body of knowledge on lean construction maturity by identifying the specific parameters relevant to the Sri Lankan context. By uncovering these region-specific factors, this research adds to the broader theoretical framework of lean construction parameters, offering insights into how cultural, economic, and institutional dynamics influence the maturity of lean practices in different contexts. As a theoretical construction to the local context, this study fills a gap in the literature by investigating key lean construction parameters in Sri Lanka. This research serves as a foundational study for understanding the state of Lean construction maturity. By

indicating the key parameters essential for determining Lean maturity in the Sri Lankan construction industry, this study lays the groundwork for future research and practice.

5.1.2 Practical Contribution

The research findings directly impact the construction sector as they provide a clear guide to lean construction parameters relevant to the Sri Lankan context. Understanding these key parameters enables practitioners to focus their efforts on areas vital for successful lean implementation to reach higher lean construction maturity. This will allow organisations to improve efficiency, reduce waste, and enhance project outcomes. Moreover, the study encourages decision-makers in the Sri Lankan construction sector to make informed choices. By realising the precise socio-economic dynamics influencing lean maturity, policymakers and industry stakeholders can develop tailored initiatives and strategies to promote lean practices effectively. This includes the development and reforming of policies, effective training programs, and support mechanisms to address the unique challenges faced in lean implementation in Sri Lanka.

5.2 THE WAY FORWARD

Identifying key parameters presents opportunities for future research to explore their validity and applicability in real-world case scenarios. Furthermore, researchers can explore how each of these parameters impact the overall success of construction projects and they can further investigate key relationships of these parameters in project settings and how their overall integration would affect the final project outcomes. These findings will lead to the development of a comprehensive conceptual model that includes all necessary model elements, providing a strong framework for assessing lean construction maturity.

6. CONCLUSIONS

Lean construction provides an innovative pathway to manage conventional construction problems. However, there is a dearth of research on lean construction and a lack of methods to evaluate lean construction maturity in the Sri Lankan context. This has hindered the utilisation of lean principles. Determining lean construction parameters is imperative to successful implementation and reaching higher lean maturity. Therefore, this study is aimed at investigating key lean construction parameters relevant to lean construction maturity in the Sri Lankan context. The Delphi technique was employed for data collection in three rounds using a qualitative approach. Content analysis was applied to analyse the data. The study unveiled 18 key parameters and proceeded to develop specific definitions for each of these parameters conforming to the Sri Lankan context. In conclusion, lean construction maturity in Sri Lanka portrays a strong alignment with the core lean construction principles as validated by experts and supported in the literature. However, practical application must consider diverse project requirements, localised techniques, and cultural diversity. Defined parameters such as value engineering, change management, and technology adoption reflect local needs while integrating global best practices. These insights emphasise the importance of transparency, standardisation, and flexibility in adapting lean construction principles to Sri Lanka's unique construction landscape. Moving forward, these findings offer a strategic guide for enhancing efficiency in the Sri Lankan construction sector through tailored lean construction practices. These findings significantly contribute to enriching the knowledge base of lean

construction maturity and offer tangible benefits to industry stakeholders by providing them with insights to reach higher lean construction maturity.

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