IMPROVING LEAN CONSTRUCTION IMPLEMENTATION IN THE CONSTRUCTION INDUSTRY: FRAMEWORK FOR ADDRESSING THE HUMAN CAPITAL RELATED BARRIERS

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by

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ABSTRACT

Lean construction is one of the attempts made to apply lean production principles to the construction industry. It aims to minimize non-value-adding activities in its construction processes and maximize the value provided to clients. Non-value adding activities generated in a construction process are recognized as one of its significant disadvantages since they adversely affect its efficiency and produce unnecessary costs. Implementation of Lean Construction is a tested strategy avoiding additional costs for the final product of the construction. Recently, Lean Construction has been widely practiced globally by implementing several tools and techniques.

However, literature review and ad hoc studies show that Lean Construction Implementation is not widely applied in many construction settings for various reasons. Therefore, exploring the barriers to implementing Lean Construction is timely and important. It is evident that half of the barriers are related to Human Capital, such as skill, knowledge, and capacities. Lean Construction is still new to many in the construction industry globally as well as New Zealand's construction industry. According to the published literature, limited publications are found in New Zealand construction industry. Therefore, the outcome of this research of developing a framework to improve Lean Construction Implementation from the Human Capital perspective would be an innovation for the country.

A preliminary literature review was conducted to identify the research gap. The barriers to Lean Construction Implementation were explored through a detailed literature review. Furthermore, a systematic literature review was done to examine how these barriers relate to Lean Construction Implementation from a Human Capital perspective. A conceptual framework was developed based on the literature findings. Qualitative methods were also used in this study in the latter part of the framework development. Firstly, twenty-four New Zealand construction industry construction professionals were interviewed through semi-structured questions and revealed some strategies to implement Lean Construction from the Human Capital perspective to overcome the barriers related to human capital. The framework was developed based on those strategies. Secondly, expert opinions were obtained from industry professionals with experience in Lean Construction Implementation and used to refine and validate the framework developed. The findings reveal that attitude, awareness, interest, leadership, training, education, teamwork, and communication within a Lean Culture are most significant in the construction industry in New Zealand to improve efficiency and productivity in construction activities.

Keywords: Human Capital, Lean Construction Implementation, Lean Culture

DEDICATION

My dedication to the College of Engineering, **Otago Polytechnic**, Dunedin, New Zealand, who offered me the position of Senior Lecturer while I was working in Sri Lanka, and for the support extended to start this research financially and every other means.

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ATTESTATION OF AUTHOURSHIP

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgments), nor material which, to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

Nilmini Ruwan Kumari Thilakarathna

CHAPTER 1 INTRODUCTION

This research aims to develop a framework to improve Lean Construction Implementation from the Human Capital perspective. This chapter presents the background to the study that presents the foundation for the topic under review. Furthermore, it discusses the problem statement that highlights the issues the study seeks to address. It also outlines the aim and objectives that were used to achieve this aim. The study's rationale and significance are also presented. Table 1.1 below lustrates section headings and the content of each heading in this chapter.

Table 1-1 section headings and content

Section headings	Section content
1.1 Background of the study	Overview of construction; introduction to Lean Construction, human perspective of Lean Construction implementation; problem statement of the thesis
1.2 Aim and objectives	The aim of the study and the objectives are presented with the research question for each objective
1.3 Rationale and significance of the study	Lean Construction as an approach to solving the prevailing issues relating to the efficiency and productivity of construction activities, but the level of implementation is slow, and it is significant to identify the strategies to improve Lean Construction Implementation
1.4 Scope	This research focuses on the barriers to Lean Construction Implementations and how to improve it from Human Capital perspective.
1.5 Research Methodology	Primary and secondary data collection strategies to achieve the objectives of the study are presented briefly
1.6 Chapter breakdown	This section presents how this thesis is organized with several chapters.
1.7 Summary	Chapter 1 is summarized with the introduction to chapter 2

1.1 Background Study

The background of the study begins with an overview of the construction industry.

1.1.1 Overview of the construction industry

Construction is a vast, dynamic, and complicated industry that plays a significant part in the economy of every country ((AlSehaimi, Fazenda, & Koskela, 2014). Construction workers and employers construct our roads, housing, and workplaces and repair and maintain our country's

physical infrastructure. Every economy relies heavily on the construction sector (Oladinrin, Ogunsemi, & Aje, 2012). It also has a significant impact on socio-economic development. According to Forbes (2020), the construction industry has traditionally been one of the largest industries in the United States. According to the Annual report 2022 published by the Ministry of Business, Innovation & Employment New Zealand, the construction sector has contributed 7.1% to its GDP. Also, this report reveals that the construction sector grew 15.3 percent between the year ended March 2018 and March 2022 and was ranked 5th in its contribution to GDP growth. The construction industry plays a critical role in the economy of any country (Forbes & Ahmed, 2020), and therefore, it is vital to identify the nature of the construction industry.

The Construction Industry is project-centric (Koskela, 2000), and construction projects have become more complex in recent years (Jaffar, Abdul-Tharim, Mohd-Kamar, & Lop, 2011). In construction, the final product has its very own nature because construction projects are unique, static, and big in size (Koskela,2000). According to (Vrijhoef & Koskela, 2000), the short-term adversarial trading relationships (Forbes & Ahmed, 2020) and the fragmented structure of the supply chain (Colon, Brännström, Rovenskaya, & Dieckmann, 2020) contribute to the considerable uncertainty and complexity of the construction industry. The quality of construction is primarily related to the conformance of the product with the specifications and drawings. There is a general perception that the construction sector derives its real success from the buildability of its designs, resulting in successfully completing projects and the durability and sustainability of its products (Othman, 2007). Notably, construction is a complex process that begins with the planning and designing of what is to be constructed. This very own nature of the construction industry encounters many challenges, and these challenges are briefly stated below.

Problems in the construction processes, i.e., low productivity, insufficient quality, time and cost over-runs, and poor safety, have been illustrated in several studies (Latham, 1994; Egan, 1998) and their findings are familiar to the industry, which is still striving for improvements in several areas, although apparently with little success. (Kagioglou et al 2000). In the construction industry, job security is low, and workers perform a range of tasks during the implementation of a project (Salem et al.,2006). The construction industry is often regarded as confrontational, risk-averse and lacking vision and trust (Barret, 2005). Also, the construction industry is still backward while other industries have modernized their practices (Vilasini et al,

2011). Moreover, the construction industry still maintains its craft methods of operation and continues to lag behind in productivity and quality and in delivering value for money to its clientele (Alinaitwe, 2008; Pheng & Li, 2011; Howell& Ballard, 1997; Koskela, 2000). Further, Lichtig (2006) has indicated that construction owners are dissatisfied in different ways, i.e., projects take too long, cost is too much, and expected quality standards are not met.

The construction industry has been suffering from low productivity and poor performance compared to other industries (Love et.al, 2015; Demirkesen, Sadikoglu, & Jayamanne, 2022) (Demirkesen, Sadikoglu, & Jayamanne, 2022). The New Zealand construction sector is similar to many other countries (Seadon and Tookey, 2019), with a few large companies and many small and micro enterprises and requires achieving a 20 percent increase in productivity. Therefore, it is evident that the construction industry has been suffering from low productivity and poor performance compared to other industries. Measuring the productivity impact of the construction industry has always been difficult due to the scarcity of dependable output deflators (Sveikauskas, Rowe, Mildenberger, Price, & Young, 2016).

Particularly in the building sector, it has been expected for architects to work with clients to understand what they want, then produce facility designs intended to deliver what was wanted (Ballard 2011). The cost of those designs has been estimated, and too often, it is found to be greater than what the client is willing or able to bear, requiring the revision of the design and thereby leading to re-costing and so on. This cycle of design-estimate-rework is wasteful and will reduce the value the clients get for their money. Most construction managers agree that the industry is vulnerable to multiple wastes, overruns, delays, errors, and inefficiency (R. Al-Aomar, 2012). In manufacturing, defective parts are largely discarded rather than reworked due to the simplicity and flexibility of the product, whereas in construction, rework is a common practice with only one final product being delivered (Forbes & Ahmed,2020).

Moreover, Forbes & Ahmed (2020 reveals that labour intensity increases the risk of human errors and quality issues are widespread in the industry. In manufacturing, manufacturer-supplier relationships are clear, more manageable, and open to repetition. However, in construction, these relations are more dynamic and complex. In the recent past, researchers have placed greater emphasis on developing ways to improve the operating systems of construction projects (Hamzeh et al., 2021) and one such method for improvement is known as Lean Construction (Singleton and Hamzeh, 2011).

1.1.2 Lean Construction

The lean concept is one strategy adopted by the construction industry learning from the manufacturing industry to improve its performance (Vilasini and Neitzert (2012); Vilasini and Rotimi, 2014). Vilasini et al., (2011) have stated that lean is an innovative construction management approach that is linked closely to the overall life of a project ensuring its success (Aziz & Hafez, 2013) for improvements in several areas, although apparently with little success. (Kagioglou et al. 2000). In addition, several construction techniques have been developed historically, particularly during the period of the industrial revolution, to aid the industry's success (Mao, Mahame, & Ndahirwa, 2018). For instance, models were formulated but could not address budget overruns, late project delivery, and poor quality ((Mao, Mahame, & Ndahirwa, 2018). These problems continued to force industry players to seek global change in the construction sector.

Lean production seeks to develop and manufacture things distinct from mass and artisan forms of production in terms of objectives and technology. Also, lean practices improve the production system's performance against an excellent standard to fulfill specific client requirements (Chiarini, Baccarani, & Mascherpa, 2018). Lean Construction enhances efficiency by smoothing the construction workflow while increasing the total value of a product to meet predefined objectives and ensure ultimate user satisfaction (Marhani, Jaapar, Bari, & Zawawi, 2013). The competent formation of service delivered to the consumer at the correct time, at a fair cost, and according to the correct quality standards is referred to as 'value.' Lean thinking can also be described as a goal established against a set of perfection measurements (Aziz & Hafez, 2013).

The plethora of options surpassing what was attainable has led businesses to focus more on customer satisfaction (Marhani et al., 2013). Customers want a variety of things at low prices and with speedy delivery. In addition, they demand more unique items at affordable costs, with more alternatives for the buyer to pick from. The primary goal of implementing lean production is to enhance product quality, boost productivity, and production cycle time, minimize waste, shorten lead times, and reduce inventory (N. Kumar et al., 2022). A lean system attempts to remove waste by using continuous improvement processes throughout the company's value chain (Forbes & Ahmed, 2020). Workers with a lean production mentality always restructure control and physical systems to achieve continuous product flow (Marhani et al., 2013).

Nevertheless, implementing lean production in the construction companies is a long-standing challenge. Transitioning into lean production has numerous issues and setbacks (Marhani et al., 2013). There are indications that achieving success in transitioning into lean manufacturing is not guaranteed (Jørgensen & Emmitt, 2008); (Alefari, Almanei, & Salonitis, 2020)). Several scholars have claimed that shifting from classical to lean production necessitates a culture shift within the business instead of addressing production or technological challenges (Zimmermann & Bollbach, 2015). Typically, transitioning into lean construction entails a fundamental shift in organisational technology, strategies and structures (Al-Sarray, Saeed, Naji and Adil, 2020). Companies have little opportunity to adopt lean construction except they have paid at least as much attention to building the correct culture as they focus on the contractual terms used to accomplish the transformation (Pekuri, Herrala, Aapaoja, & Haapasalo, 2012).

The term "lean" was coined by a research team working on worldwide auto production to highlight the Toyota production system's waste reduction characteristics and to contrast it with artisan and mass production methods (Roos, Womack, & Jones, 2014). A simple set of objectives for the design of the production system was developed based on efforts to minimize machine setup time and influenced by total quality management, including (1) identifying and delivering value to the customer value: removing everything that does not add value; (2) organize production as a constant process; (3) perfect the product and create reliable flow via distributing information and decision making; and (4) pursue perfection: deliver an order to meet customer requires without anything left in inventory (Aziz & Hafez, 2013).

Lean thinking has evolved into a radical philosophy that has infiltrated and gone beyond the manufacturing industry. With its contribution to sustainable building, the notion of Lean thinking promotes the improvement of workflow-related functions and possible outcomes. As a result, applying lean theories and concepts to the construction industry has the capacity to boost work quality, reduce cost components/waste, increase function-related effectiveness, and dramatically increase profit at both the strategic and operational levels (Bajjou & Chafi, 2018). Lean methodologies have significantly contributed to several possible cost reductions compared to traditional project management procedures (Forbes & Ahmed, 2020).

According to Womack and Jones (2003), the five principles of lean thinking are value, value stream, flow, pull and perfection. Lean Construction is defined by necessary concepts, basic

practices, and common terminology. Together these create a new paradigm for managing work in projects from their conception to completion. Koskela (1992), Womack (1996) and Ballard (2008) have refined and expanded the lean concept for construction and have outlined the basic lean thinking principles. Below, table 1.2 illustrates the five principles of lean thinking.

Table 1-2 Lean Principles

Lean Principle	**Description**	**Reference**
Value	Precisely specify a value from the perspective of the ultimate customer	(Ballard, 2008) (Koskela, Howell, Ballard, & Tommelein, 2002; Womack & Jones, 1996) Forbes and Ahmed (2020), Koskela (1992)
Value stream	Clearly identify the process that delivers what customer values (the value stream) and eliminates all non-value-adding steps.	
Flow	Make the product flow or organize the production in a continuous flow.	
Customer Pull	Do not make anything until it is needed, then make it quickly	
Perfection	Manage towards perfection by continuous improvements and deliver on order a product meeting customer requirement with nothing in inventory	

The values normally recognized in the construction industry are quality, time, and cost. (Wu. P and Low S. P (2011). The lean concept has proven to be effective in increasing environmental benefits by eliminating waste, preventing pollution, and maximizing the owners' value (Huovila and Koskela, 1998; Salem et al. (2005): Bae and Kim (2007): Peng and Phene (2010). The lean concept has been introduced to different projects in the construction industry at varying levels of success. (Forbes & Ahmed, 2020) state that as far as a construction company is concerned, lean will involve two significant paths, i.e. best people and systems in place to control them. However, there are no studies in the New Zealand Construction Industry to identify how human intervention is affected by the Lean Construction Implementation. The following section discusses Lean Construction from a Human Perspective.

It is evidenced that Lean Construction is one method for addressing the problem and applying a new type of production management to the building industry results in Lean Construction (Forbes & Ahmed, 2020). Although all activities incur costs and consume time, Lean Principles state that only conversion activities add value and that therefore these should be made more efficient, whereas non- value adding flow activities should be reduced or eliminated (Koskale, 1993). By eliminating wasteful activities, processes can become 'lean', providing 'more with

less' resources (Womack and Jones, 2003). However, Aslam et al., 2020; Enshassi et al., 2021 have revealed that the construction sector still finds it challenging to exploit all its advantages, either because of a lack of awareness or complicated implementation methods. Therefore, the next section discusses the human perspective of Lean Construction to identify the barriers to Lean Construction Implementation.

1.1.3 Human perspective of Lean Construction

The two most important variables influencing the construction industry's development are construction management and technology (Dixit, Mandal, Thanikal, & Saurabh, 2019). Though various new and advanced technologies have been introduced to construction projects over the last four decades, the industry's efficiency has remained relatively low (Enshassi, Saleh, & Mohamed, 2021). The fundamental reason for this seems to be that new technologies cannot effectively reduce design and construction costs while also enhancing construction process management (Forbes & Ahmed, 2020). For example, while computer-aided design technology has improved drawing efficiency, it cannot eliminate design errors, resulting in the requirement for construction rework, making it difficult for construction managers to maximise the construction process to save money (Hamzeh et al., 2021).

Concerning the human perspective of Lean Construction, numerous investigations show that lean methods' implementation results in work intensification (Cappelli & Rogovsky, 1994). Simultaneously, its expansion was primarily driven by the rise in the population's proportion to tertiary education (Schofer & Meyer, 2005). Nonetheless, about half of the people in advanced economies now possess a tertiary degree, making additional capacity harder (Prichina, Orekhov, Evdokimova, Kukharenko, & Kovshova, 2019). The increase in the workforce is likewise decreasing. As a result, there is an urgent need to use new human-connected tools, such as implementing "Lean Construction" (Prichina et al., 2019).

Notwithstanding Lean's established economic efficiency, efforts at mass deployment keep failing, regardless of positive dynamics (Pay, 2008). According to (Bocquet, Dubouloz, & Chakor, 2019), human resource management and lean have different relationships at various stages while implementing lean (Forbes, 2020). Interestingly, when employees are motivated, it significantly impacts the degree of success of the lean implementation process (Castro, Figueiredo, Pereira-Guizzo, & Passos, 2019).

The critical problem towards becoming Lean is "how to develop an integrated company of employees who each share the firm's culture and acquire new skills together to deliver value to the customer" (Wangwacharakul, Berglund, Harlin, & Gullander, 2014). This can be realized using measures that promote learning, including experience sharing and knowledge re-use. These are included in this essential Lean production concept of collaboration and continuous improvement (Kaizen), such as work values and cross-functional work, both inside and across teams, enabling knowledge exchange and skill growth (Ismyrlis, 2021). High-performing teams in companies are significantly effective in creating corporate value, growing, and achieving a firm's predefined and emerging goals and expectations. Team building increases service quality, work efficiency, overall good performance, and growth (Masanja & Chambi, 2020). Furthermore, team building promotes ongoing growth, transparent and pleasant collaboration, and the implementation of specific members' trust and leadership capacity (Forbes & Ahmed, 2020).

The major pitfalls of Lean Construction's human perspective include a lack of transparency (Bashir, Suresh, Oloke, Proverbs, & Gameson, 2015), a lack of participative management/leadership (J. Sarhan, Fawzia, B., Karim, A. and Olanipekun, A., 2018), and rigid organizational structures/procedures. Additionally, it includes a lack of teamwork (Al Balkhy, Sweis, & Lafhaj, 2021), misconceptions about Lean Construction, lack of self-criticism, not developing in-house lean competency. Moreover, pseudo-lean implementation for secondary purposes, challenges in instituting a changing culture, fear of unfamiliar practices, rigid organizational structures/procedures, too complex, over-enthusiasm, leadership conflict, poor leadership, and high personnel turnover (Bashir et al., 2015), are included in Lean Construction's human perspective. Accounts of prospective Lean Construction success stories are commonly quoted. However, unreported lean failures provide exceedingly substantial learning opportunities for the industry (Kariyawasam and Siriwardana (2021).

1.1.4 Problem Statement

Construction projects are notorious for being delayed, and cost and time overruns are common (Sorooshian, 2014). A substantial amount of waste in the construction sector has harmed the industry's overall performance and productivity, and serious steps must be taken to address the problem (Aziz & Hafez, 2013). According to the Lean Construction Institute (2014), the construction industry accounts for around fifty-seven percent of all productive time waste. Traditional construction techniques are ineffective in addressing construction industry issues.

Focusing on lean principles of reducing waste and enhancing productivity makes it simple to apply to the construction domain to create more successful projects. The lack of information or complicated procedures has made the construction sector struggle to take advantage of the full benefits of lean (Aslam, Gao, & Smith, 2020). Furthermore, most previous investigations have mainly focused on lean tools and the deployment of new technology. However, it is evident that there is still much progress to be made in this area. Adopting the best lean methodologies alone does not guarantee its implementation will succeed (Forbes, 2020). Recognizing the Lean Culture is required to aid firms in efficiently implementing and maintaining lean techniques. Consequently, some past research has attempted to discover the behavioural dynamics of a healthy Lean Culture (Van Dun & Wilderom, 2012).

In terms of continuous improvement, the lean approach to teamwork is a key differentiator (Caliskan, 2016). Accordingly, various academics have underscored the need for collaboration in construction projects. According to (Spatz, 2000), the sector that should recognize teamwork's significance more than other sectors is the construction sector. His research suggests that collaboration may be related to the construction project's cultural heritage and foundation. Furthermore, building projects' intricate technical and social characteristics necessitate cooperation to enable expert employees to work cooperatively on job sites or throughout the project's design stages.

In general, construction projects' teamwork activities aim to improve individuals' interactions with one another. This is consistent with the two pillars of lean implementation underlined in the work (Liker, 2004): "Respect for People" and "Continuous Improvement." Similarly, lean manufacturing is defined as a socio-technical system that reduces internal, customer, and supplier variability to minimize waste (Shah and Ward, 2007). As a result, focusing on the social side of lean production and the technical processes involves research into the human perspective of Lean Construction (Forbes & Ahmed, 2020).

Creating the team component of the lean strategy is more complex than simply implementing lean tools. Developing and sustaining an effective team environment is among the most challenging problems in implementing lean (Asadian & Leicht, 2021). From a probabilistic standpoint, the conceptual basis of "Lean thinking" or "Lean behaviour" was stated that the emerging Lean fundamental values might be tailored to the particular instances of various firms

and sectors (Caliskan, 2016) as a typical component of their operations. Most of the scholars who have researched Lean Construction recognize the enormous changes this construction approach has on the human resource management of businesses (Green, 2002). The new lean construction processes cannot be easily implemented into an enterprise without carefully considering various human resources challenges (Ahmed & Sobuz, 2019). While the core of Lean Construction methods is generally known, the Human Resource process difficulties relating to change implementation are not (Ciano, Strozzi, Minelli, Pozzi, & Rossi, 2019).

It is important to emphasize that implementing Lean Construction is insufficient without commitment, great employee competence, good leadership, long-term connections with partners, and other human characteristics. Hence, the research question emerges: How to improve Lean Construction Implementation from Human Capital perspective?

1.2 Rationale and Significance of the Study

According to (Tommelein, 2015), Lean Construction has been widely used as a process-oriented method that evolved from the Toyota Production System to deliver exceptional capital projects in the architecture–engineering–construction industry. In the meantime, Lean Construction research has piqued the interest of several academics, who have investigated the subject matter from different angles. These include Lean Construction's interaction with prefabrication technology and Information Technology (Koskela, 1992; Said, 2015);(Li et al., 2018) LC theories and principles (Shewchuk & Guo, 2012); (Ko & Chung, 2014), and Lean Construction's value to sustainability (P. Wu, Low, & Jin, 2013).

Extant literature discussing lean construction is numerous (S. Singh & Kumar, 2020); (Habibi Rad, Mojtahedi, Ostwald, & Wilkinson, 2022);(Ansah, Sorooshian, & Mustafa, 2016); (Parfenova, Avilova, & Ganzha, 2020). There has recently been a rise in investigations relating to the impact of the human dimension on the performance of Lean production. Before 1990, a considerable number of investigations had concentrated on the technical aspects of operation and not the people-based difficulties (Power & Sohal, 1997). From then on, there has been a more significant emphasis on "why" Lean Production works (or fails), and consequently, human resource management -related variables have gained more attention (Forbes & Ahmed, 2020). Accordingly, most of the literary works discussed perspectives such as improving construction supply chain collaboration and performance: a Lean Construction pilot project

(Eriksson, 2010), ("An appraisal of lean construction project delivery application of lean construction," 2016), and many others.

Moreover, such discussions are consistently and continuously changing due to adding keywords and developing more specific subjects over time (Li, Wang, and Lei, 2019). Notably, the literature discussing Human Capital perspectives of Lean Construction exists (Green, 2002). As underpinned above, numerous studies examining the human dimension of lean construction exist. However, the ones that exhaustively discussed the Human Capital perspective of lean construction are scarce. Consequently, it becomes expedient to discuss further the Human Capital perspectives of lean construction implementation to determine novel issues and highlight areas that require further studies.

This research is significant because its findings can benefit many parties such as Clients, Contractors, Consultants, and Project managers in the construction industry by enabling them to improve the efficiency of their construction processes through the minimization of non-value-adding activities. This is because the return benefits they gain by spending their funds on a particular project can even be considered an investment and will continue to increase if they can minimize non-value-adding activities. Consequently, the costs, time, and resources saved from lean construction can increase the stakeholders' level of satisfaction, compelling them to make more investments in the industry and expect higher returns.

1.3 Aim and Objectives

This research aims to develop a framework to improve Lean Construction Implementation from the Human Capital perspective. The following objectives were used to achieve this aim.

Objectives:

1. To identify the barriers to Lean Construction Implementation in the construction industry.
2. To assess the Human Capital-related barriers in Lean Construction Implementation in the construction industry.
3. To evaluate the strategies for improving Lean Construction Implementation in the construction industry from the Human Capital perspective.
4. To develop the framework for addressing the Human Capital related barriers in Lean Construction Implementation.

The research questions were formulated as shown in below table 1.3 to achieve the objectives of this research.

Table 1-3: Objectives and research questions

Objectives	**Research Questions**
Objective 1: To identify the barriers to Lean Construction Implementation in the construction industry	Research Question 1: What factors affect the implementation of Lean Construction? Research Question 2: What are the barriers to implementing Lean Construction? Research Question 3: How are these barriers related to the Human Capital perspective?
Objective 2: To assess the Human Capital-related barriers to Lean Construction Implementation in the construction industry	Research Question 4: How to define Human Capital in Lean Construction Implementation? Research Question 5: How to evaluate the barriers in Lean Construction Implementation from Human Capital perspective? Research Question 6: What are the most critical barriers in Lean Construction Implementation from Human Capital perspective?
Objective 3: To evaluate the strategies for improving the Lean Construction Implementation in the construction industry from the Human Capital perspective.	Research Question 7: What are the widely suggested strategies to overcome Human Capital barriers in Lean Construction Implementation?
Objective 4: To develop the framework for addressing the Human Capital related barriers in Lean Construction Implementation.	Research Question 8: What are the most suitable strategies to improve Lean Construction Implementation from Human Capital perspective?

1.4 Scope

This research focuses on developing a framework to improve Lean Construction Implementation from the Human Capital perspective. As a result, it examines the current state of the construction sector and the concept of Lean Construction. It investigates the Human

Capital perspective of Lean Construction. Consequently, it develops a framework that can be used to improve Lean Construction Implementation from the Human Capital perspective.

As earlier mentioned above, the literature discussing Lean Construction is numerous (S. Singh & Kumar, 2020); (Habibi Rad et al., 2022); (Ansah et al., 2016); (Parfenova et al., 2020). It should be noted that the literature discussing Human Capital perspectives of lean construction exists (Green, 2002). However, the ones that exhaustively discussed the Human Capital perspective of Lean Construction are scarce. This poses a challenge as it becomes difficult to obtain resources that can be used to draw valid inferences regarding the Human Capital perspective of Lean Construction.

1.5 Research Methodology

The framework of this research was based on the research onion approach. According to Raithatha (2017), the research onions provide an in-depth explanation of the essential layers or steps that must be used to develop an effective methodology. The pragmatism research philosophy was the adopted research philosophy used in this study. Meanwhile, the research approach used is the deductive research method. This thesis used the mono method as the research choice.

The qualitative research approach was used to develop a framework for improving the Lean Construction Implementation from the Human Capital perspective. The methodology of the research consisted of the following steps.

i. **A preliminary literature review** of Lean Construction Implementation was used to explore the key barriers to implementing Lean Construction. This literature review revealed the reasons for the slow implementation of Lean Construction by verifying the research background.
ii. **A detailed literature** review was conducted to identify how the barriers to Lean Construction Implementation are related to Human Capital, which is the skill, experience, and attitudes of humans. Findings reveal that there is an evident link between the barriers to Lean Construction Implementation and Human Capital area.

iii. **A systematic literature review** was conducted to provide a clear, targeted answer to specific research questions. The literature was critically evaluated to explore the relationship between the barriers to Lean Construction Implementation from the Human Capital perspective and what are the strategies to overcome them.

iv. **Semi-structured Interviews** were used to collect primary study. The adopted interview method was the semi-structured interview method. Twenty-four construction professionals, including architects, engineers, quantity surveyors, and project managers, were the participants in the interviews.

v. **Experts' opinions** were obtained to validate the framework developed through this research. Five experts who have experience in Lean Construction Implementation for more than ten years were identified and interviewed to refine and validate the developed framework. The experts consulted included the lean manager, lean trainer, continuous improvement manager, lean practitioner, and lean coach.

On the other hand, regarding the internal validity, this study developed a conceptual framework through the literature review; the research was designed based on this conceptual framework. A systematic literature review was carried out to propose a framework, and this framework was mapped with the data obtained through in-depth interviews. This thesis's external validity was achieved by establishing an appropriate unit of analysis and sampling strategies. The unit of analysis of this study is identified as the "construction professional" in the construction industry, and purposive sampling was carried out to generalize the findings. The findings of this thesis are reliable. This is because the interview guideline was prepared to capture the data around the research question in this study. Also, the same interview guideline was used for all participants. Thus, it ensured consistency across the unit of analysis.

1.6 Chapter breakdown

There are seven chapters, and the below figure demonstrates the structure of the thesis with the contents of each chapter.

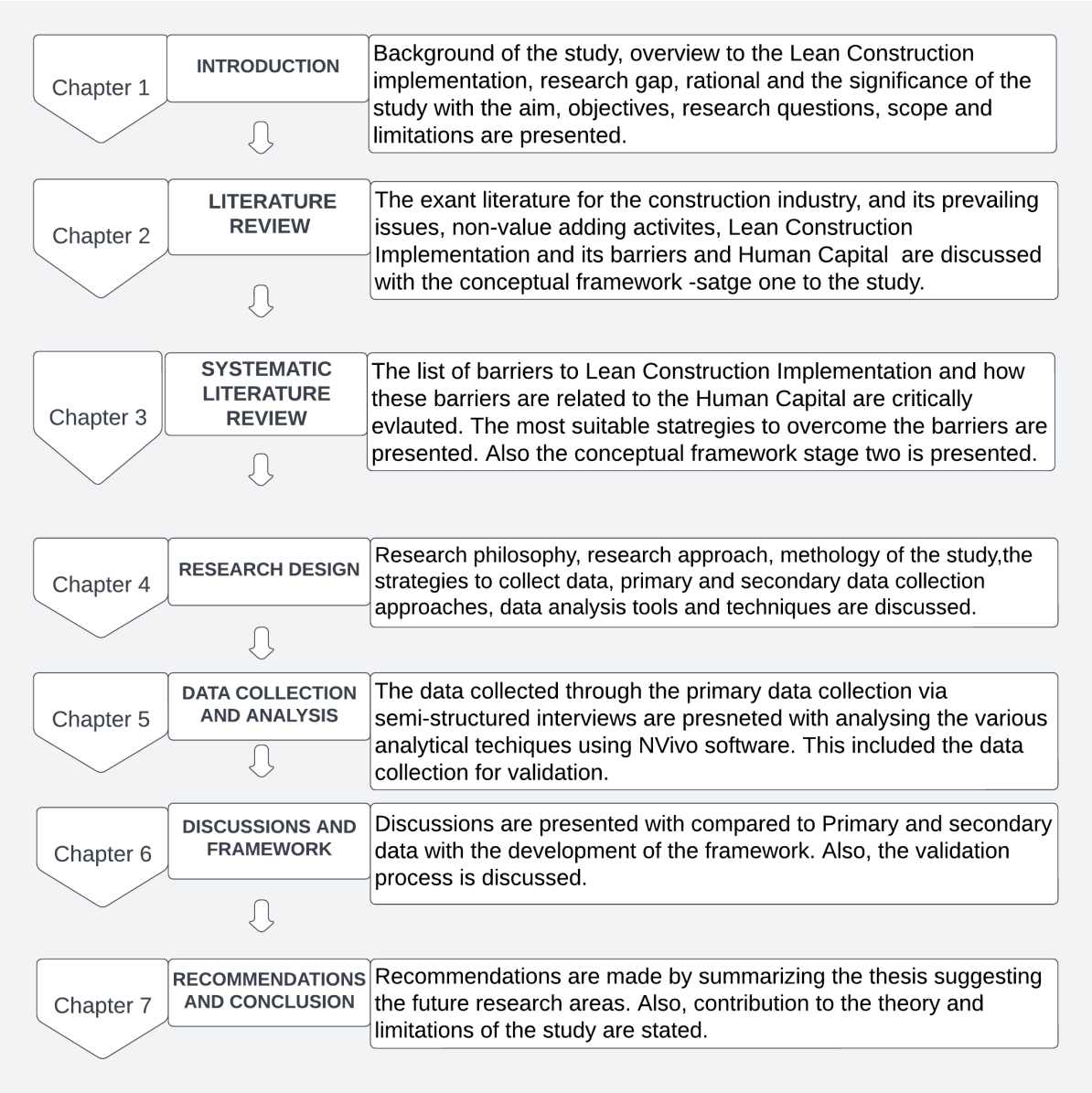

Figure 1-1: Chapter Breakdown

1.7 Summary

This research primarily focuses on developing a framework for implementing Lean Construction based on the Human Capital dimension. As such, it provided the related background from existing literature, presenting an overview of the construction industry, Lean Construction, and the Human Capital aspect of Lean Construction. It also presented a problem statement. There, it derived that it is important to emphasize that the deployment of lean tools or activities will be insufficient without commitment, great employee competence, good leadership, long-term connections with partners, and other human characteristics. There, it underpinned specific challenges related to Lean Construction. This framework can benefit many parties in the construction industry by enabling them to improve the efficiency of their construction processes through the minimization of non-value-adding activities. This is because the return benefits they gain by spending their funds on a particular project can even be considered an investment and will continue to increase if they can minimize non-value-adding activities. Consequently, the costs, time, and resources saved by Lean Construction can increase the stakeholders' level of satisfaction, compelling them to make more investments in the industry and expect higher returns.

The thesis highlighted that numerous studies examining Lean Construction's human dimension exist. However, the ones that exhaustively discussed the Human Capital perspective of Lean Construction are scarce. Consequently, it becomes expedient to discuss further the Human Capital perspectives of Lean Construction in improving construction flow to determine novel issues and highlight areas that require further studies The different methodologies used to achieve this project were also discussed. This study's framework was based on the research onion approach. The pragmatism research philosophy was the adopted research philosophy used in this study.

The next two chapters present the secondary data collected for this study to frame an answer to the key research question of this study.

CHAPTER 2 LITERATURE REVIEW

~~The secondary and primary data were collected to answer the research question for this study.~~ This Chapter and the next Chapter (Chapter three) present the secondary data, whereas Chapter five presents the primary data collected. This Chapter discusses the extant literature available on Lean Construction Implementation and the barriers to implementing Lean Construction. Also, how these barriers are related to the Human Capital perspectives is further discussed. Finally, this chapter proposes a conceptual framework to synthesize the concepts and empirical findings from the literature. Moreover, below table 2-1 shows the sub-sections, headings, and contents of this chapter.

Table 2-1 Chapter 2 section headings and contents

Section headings	**Section content**
2.1 Factors affecting Lean Construction Implementation	First, the nature of the construction industry and the related issued are discussed. Next, the existence of non-value-adding activities in the construction processes is reviewed. Finally, the sources for non-value adding activities are presented.
2.2 Lean Construction	This section begins with an overview of Lean Construction, then the lean principles are presented. Next, the widely used lean techniques are discussed. In the end, Lean Construction Implementation is discussed.
2.3 Barriers to Lean Construction Implementation	The barriers to Lean Construction implementation are identified, discussed, and tabulated. Moreover, these barriers are critically evaluated to see how the barriers are related to the Human Capital area.
2.4 Defining Human Capital Concept in Lean Construction Implementation	First, this section defines the Human capital and then the Human Capital concepts are presented. Next, the underlying causes for the human capital factors are discussed. Finally, this section introduces the Human capital development in Lean Construction Implementation.
2.5 Conceptual framework	This section presents the conceptual framework – Stage 1 developed through the findings based on the detailed literature review.
2.6 Summary	Chapter 2 is summarized with the introduction to chapter 3.

This research aimed to develop a framework to improve Lean Construction Implementation from the Human Capital perspective. First it is vital to discuss 'What *factors affect the implementation of Lean Construction*?' and this discusses in the following section.

2.1 Factors affecting Lean Construction Implementation

Lean Construction emerges to solve the numerous issues in the construction industry. Hence, reviewing the construction industry before identifying the factors affecting Lean Construction Implementation is significant. First, the nature of the construction is considered below.

2.1.1 Nature of the construction industry

The construction sector is project-based and operates in a very complicated and uncertain environment (Manukyan & Papadonikolaki, 2019). This may be caused by the supply chain's fragmented structure (Mohd Nawi, Baluch, & Bahaudin, 2014) and transient contentious commercial relationships (Kim, Chang, & Castro-Lacouture, 2020). Since building projects are distinctive, static, and substantial in size, the finished product has a distinct nature (Oyewobi, Jimoh, Ganiyu, & Shittu, 2016). In addition, the construction sector stands out from other sectors due to three key characteristics: on-site production, complexity, and one-of-a-kind project (Albalkhy & Sweis, 2021). In a normal project structure, the client, contractor, and designer focus on their interests, and communication typically follows contractual guidelines. Additionally, various activities, such as delivering technical and professional services, are included in the construction sector (Cha, Newman, & Winch, 2018). Further, scores of decisions must be made during the construction process, sometimes over the years, with many interdependencies and in an inherently unpredictable environment (Bakht & El-Diraby, 2015). Table 2-2 below depicts the nature of the construction industry.

Table 2-2 Nature of the Construction Industry.

Nature of the Construction Sector	Description	Sources
Project centric industry	According to Vrijhoef and Koskela (2005), project-based production dominates the construction industry, and production institutions are built by autonomous players joining irregular, changeable alliances of enterprises. This has impacted the industry's processes and structure, creating a highly fragmented market with a wide range of businesses. The construction sector is a classic example of a project-based sector.	(Vrijhoef & Koskela, 2005) (Emblemsvåg, 2020)
It operates within an environment of complexity and uncertainty	Building renovation projects are notorious for their high level of complexity and uncertainty, which frequently incorporates issues like design changes and insufficient or conflict-prone information	(Noori, Saruwono, Adnan, & Rahmat, 2016).
Short-term, adversarial relationships	Construction projects that are transient and short-lived make it harder for participants to build mutually supportive relationships over the long term, which breeds conflict.	(Nguyen et al., 2018)

	Five elements were identified as the causal factors of the barriers: a lack of support and engagement from the parties, insufficient knowledge and expertise, a combative attitude and adversarial behaviour, flaws in the contract structure, and intrinsic challenges in supply chain management in the construction sector.	(Kim, Chang, & Castro-Lacouture, 2020),

The literature review shows that the construction industry has its own nature to operate. Next, it is important to review the status of the construction industry before identifying the prevailing issues in the construction industry to propose Lean Construction Implementation to solve them.

The construction sector contributes significantly to the economy (Love et al, 2015), and its activities are essential to achieving the nation's socioeconomic development objectives of fostering housing, infrastructure, and jobs (Pheng & Hou, 2019). The development of the construction sector benefited greatly from the use of steel (Moynihan & Allwood, 2012). However, building companies have improved their versatility and creativity in the twenty-first century. The construction industry is at an interesting stage of evolution (Forbes & Ahmed, 2020). There are both a recession and new technologies that pave their path within the building business (Singh, Kumar, Mittal, & Verma, 2023). It appears that entrepreneurs and managers alike should also implement new strategies and attempts to maintain their positions in their fields.

This study was done in New Zealand, and the primary data was obtained from the construction professionals in the New Zealand construction industry. Therefore, it is vital to explore the status of the New Zealand Construction Industry. According to New Zealand Immigration, the official government guideline to live and work in New Zealand (2023), construction is the fifth largest sector in New Zealand's economy, employing just over a quarter of a million people. Total construction value in 2019 reached $43.2b. The residential building is the largest contributor to the sector, accounting for 55% of construction activity in 2019. The remainder is split roughly equally between non-residential construction and infrastructure. Furthermore, New Zealand Immigration (2023) has revealed the following table 2-3.

Table 2-3 New Zealand Construction Industry adopted from New Zealand Immigration (2023).

Retrieved from https://www.live-work.immigration.govt.nz/work-in-new-zealand/job-market-key-industries/construction.

• Employment in construction has grown regularly since 2012.
• A critical shortage of residential housing and heavy government investment in infrastructure to modernize existing assets.
• Prepare for climate change and to help grow the economy after the COVID-19 pandemic".
• Around 4,800 new jobs a year will be created in construction in the year 2028, according to the government's medium to long-term employment outlook.
• Many of those jobs will have to be filled by people from overseas.
• Most jobs will be in residential buildings.
• Many of these jobs will be in New Zealand's largest centres of population – Auckland, followed by Christchurch and Wellington, along with the Waikato region (main city Hamilton) and Bay of Plenty (Tauranga).
• The fastest-growing sector will be infrastructure. This will be dominated by transport, water, and subdivision projects and will be strongest in Auckland, Waikato, and the Bay of Plenty.

The above table shows how New Zealand's construction industry is a significant contributor to the country's economic activities. Therefore, there is a pressing need for the construction industry in New Zealand to develop sustainable practices to improve productivity and efficiency in construction activities. Globally, there are new approaches developed and implemented to enhance productivity and efficiency in the construction industry, and some of them are identified in below table 2-4.

Table 2-4 New Approaches to improve productivity and efficiency.

Using green building practices	Green or sustainable construction is quite popular today (Patel & Patel, 2021). The amount spent on energy-efficient buildings increased in 2019 for the first time in the previous three years, with investments in building energy efficiency rising to USD 152 billion globally in 2019, a 3% rise from 2018. (United Nations Environment Programme Report, 2020).
Modular building	Construction is transitioning to modular materials in addition to the green movement (Jiang, Zhao, Wang, & Xing, 2019). It makes sense why modular construction projects are growing in popularity. Besides, they finish between 20% and 45% quicker (Bertram et al., 2019). Additionally, construction expenditures are reduced by 20% (Compare Camp, 2022). In addition, at this time, it seems likely that the West Coast of the US, the UK, Singapore, and Australia will emerge as the next hubs for modular construction (Bertram et al., 2019). This results from the housing and labour shortage in such areas and nations.
Construction Equipment Innovations	Every construction infrastructure is evolving; it is now integrating some of the most cutting-edge innovations from the computer and other sectors (Qi, Razkenari, Costin, Kibert, & Fu, 2021). Construction firms can benefit from numerous modern construction technologies, including decreased labour and material costs, shortened project timeframes, better product quality, and increased worker safety. They can also contribute to larger economic and societal benefits, such as cheaper building and infrastructure costs, reduced environmental negative effects, and longer careers for construction employees (McCoy & Yeganeh, 2021). Some of the emerging technologies used in the construction sector include robotics, augmented and virtual reality, unmanned aerial vehicles (UAV), and Autonomous Construction Vehicles, to mention a few (McCoy & Yeganeh, 2021)
Building Information Modelling	Building information modelling uses digital representations of a building's physical and functional attributes to inform decisions made during construction and use (Matthews et al., 2015). Building information is digitalized using BIM and aesthetically integrated into a quantifiable 3-D model interface (National Institute of Building Sciences, 2017).
Prefabricated Construction	Prefabrication is a phrase used in the building industry to characterize assemblies created in processing factories and brought to the construction site (Li, Shen, Wu, & Yue, 2019). Lean production is sometimes facilitated by modular construction, which may be considered a combination of manufacturing and building (Innella, Arashpour, & Bai, 2019).
Automated Systems	Even if Google and its allies find it difficult to put autonomous vehicles on the road, along with other internet heavyweights and well-known brands in the car sector, businesses working on construction equipment are more successful (Vasconcelos, Soares, & Heineck, 2012). The globe may indeed witness more quickly deployed construction equipment.
Equipment interacting with one another	This trend is related to the preceding one. Moreover, devices have been linked due to the growth of the Internet of Things (Gupta & Quamara, 2020). They can converse thanks to this. As a result, no need for users to change the settings of one device to match those of another. When

	coupled with IoT, construction equipment follows the same rules. This will increase their effectiveness and encourage improved site safety.
Software Innovations for Construction practitioners	Improvements are not just being made to the equipment. Additionally, software solutions are evolving. They incorporate some of the cutting-edge technology now accessible, similar to machines. For instance, businesses may now pick from a wide variety of construction management or estimating software (Christianson et al., 2017).
Cloud-Based Building Information Modelling	Building Information Modelling was designed to resolve the lack of consultant cooperation in the Architecture, Engineering, and Construction sector. Through the project life cycle, spanning concept design to detailed construction drawing stages, advancements in cloud BIM have enabled simple data transmission and real-time cooperation among consultants (Onungwa, Olugu-Uduma, & Shelden, 2021)
Artificial Intelligence Use	The capacity of AI to lower building costs will likely lead to its increased adoption (Al Balkhy et al., 2021). Additionally, it can create prediction models that help team members and project managers decide whether a given timeline is reasonable. Using AI in software for the construction industry can also improve security (Lv, Chen, Lou, & Alazab, 2021). Running scenarios and stress testing make this feasible. AI is also being investigated as a potent tool to minimize fatalities and injuries on building sites, raising the sector's economic and human costs (Regona, Yigitcanlar, Xia, & Li, 2022).
Virtual and augmented reality	In the context of security, virtual and augmented reality are already being used by construction teams to protect employees (Ramos-Hurtado, Muñoz-La Rivera, Mora-Serrano, Deraemaeker, & Valero, 2022). This will enable them to spot structural weaknesses before they become a serious threat. Additionally, they can employ technology to prepare for accidents and limit damages. With remote control, virtual and augmented reality can potentially change the construction sector. For instance, a business in China showed how users might operate equipment remotely. Since they are no longer subject to inclement weather, this is highly helpful when digging. As a result, their security is assured.
Working together in space	Besides being more accessible, it also makes it possible for team members to collaborate easily. This implies that they can communicate verbally as well as by phone, email, and text, even if some are in the office and others are present. However, they may use a collaborative BIM to accomplish it graphically and interactively. By cooperating, construction teams can also achieve schedule, cost, and quality goals (Al-Ashmori et al., 2020).
Software Innovations for Construction practitioners	Improvements are not just being made to the equipment. Additionally, software solutions are evolving. They incorporate some of the cutting-edge technology now accessible, similar to machines. For instance, businesses may now pick from a wide variety of construction management or estimating software (Christianson et al., 2017).

The above table shows the new approaches adopted in the construction industry to improve construction performance. However, there are still numerous productivity and efficiency issues in the construction industry. These issues range from project delays and cost overruns to company collapses, construction quality deficiencies, skills shortages, technological illiteracy, and the adversarial nature of project relationships in the New Zealand construction industry

(New Zealand Institute of Building, 2021). Therefore, the following section presents the issues in the construction industry through literature.

2.1.2 Issues in the construction industry

The construction industry has struggled with low productivity and lack of efficiency for decades. According to Thomas *et al.* (2010), a construction project delivery system mainly consists of three domains; i) project organization or the way parties to a contract are organized; ii) project operating system, or the way a project is managed on an overall and a day-to-day basis and iii) commercial project terms, or the contract. The second domain, the project operating system, is considered in this study. Most construction projects are highly complicated, have a wide range of stakeholders, and have compressed lead times for beginning, designing, and finishing (Forbes & Ahmed, 2020). In recent decades, numerous authors have investigated issues in the construction industry. These are job turnover, time and cost overruns, low productivity, inadequate quality, and poor safety. Their findings are well-known to the sector, which is still working to improve in several areas, though ostensibly with little success (Ibironke & Ibironke, 2011). These factors are summarized in the below table 2-5.

Table 2-5 Issues in the construction industry

Job Turnover	The sector also has the issue of job security. When a project is being implemented, workers in the construction industry undertake various responsibilities with little job security (Mathebula, Mulenga, Clinton, & Wellington, 2015). Happy employees feel more committed to the company they work with. The workforce's productivity is the most important factor in the construction industry. Although numerous variables, including personal concerns, motivational factors, stress, wage issues, and supervisory problems, might influence the likelihood of turnover, job satisfaction is typically one of them (Koundinya & SundaraRajan, 2019).
Time and Cost Overruns	Since time and cost have an equal positive and negative impact on all project participants, they are the two primary indices of project success in construction (Idike et al., 2021). However, the global construction business has been plagued by serious problems with time and cost performance (Johnson & Babu, 2020). Also, change orders from customers, erroneous time estimates by consultants, delays in getting government permissions and approvals, unrealistic customer completion dates and timelines, and client and consultant design variations constitute the top five reasons for time overruns. (Bin Seddeeq, Assaf, Abdallah, & Hassanain, 2019) Noted that improper procurement methods, client budgetary constraints, client delays in making decisions, inaccurate cost projections, and design inconsistency comprise the top five reasons for cost overruns.
Low Productivity	The construction process is distinct in its lengthy execution time, numerous processes, and stakeholders. As a result, labour productivity is influenced by a variety of factors (Awad, Guardiola, & Fraíz, 2021). The degree to which the product complies with the requirements and drawings is the main determinant of construction

	quality. Moreover, the construction sector is frequently seen as combative, risk-averse, and without vision and credibility (Vilasini, Neitzert, & Rotimi, 2011).
Inadequate Quality	Providing quality means going above and beyond what customers expect (Goetsch & Davis, 2014). The American Society of Civil Engineers [ASCE] (2012) offers the following comprehensive definition of quality in construction projects: Quality is measured by the extent to which the relevant stakeholders in a construction project fulfill their commitments to one another (Becerik-Gerber, Ku, & Jazizadeh, 2012) Poor quality causes cost, time, and safety issues affecting the construction sector (Abd El-Karim, Mosa El Nawawy, & Abdel-Alim, 2017)
Poor Safety	Accidents that result in injuries and deaths are still a problem for the construction industry, which has the unfortunate distinction of being the industrial sector with the highest rate of occupational accidents (Saeed, 2017). The main causes of accidents on construction sites are dangerous human behaviour (i.e., individual variables) and risky working environment (i.e., system factors). Additionally, falls are a major issue, one that affects the entire global construction sector.
Rising Cost of Materials	The economy and housing costs are impacted by an inflationary rise in the cost of construction materials. In both advanced and emerging nations, there is a general tendency toward rising building material prices. The high cost of housing is caused by rising building material prices (Danso & Obeng-Ahenkora, 2018). The issue is similar in developing nations, where the cost of building supplies keeps rising. According to a study (Odediran & Windapo, 2017), among other things, the cost of the building is impacted by the price of building materials in South Africa. Due to the rise in the price of construction materials like cement between 2008 and 2009, the cost of building new homes in Namibia climbed significantly (Mosha, 2011). (Pashardes & Savva, 2009) study claims that the rise in home prices in Cyprus between 1988 and 2008 is a result of rising building material costs.
Shortage of skilled labour in the construction sector	One of the biggest issues facing the construction industry in recent years was the lack of competent personnel (Kim et al., 2020). Every construction project depends heavily on skilled labour, which has become increasingly crucial as construction project delivery has become more sophisticated and technological (Akomah, Ahinaquah, & Mustapha, 2020). Since most activities on-site depend on skilled labourer, any shortfall negatively impacts the construction sector. In the construction industry, improvements in project performance brought about by improvements in skilled labour have long been significant. It is widely known that labourers' talents throughout project execution determine project performance, and their abilities can influence the project's progress to a greater or smaller extent (Hussain et al., 2020). For most building projects, this is true. The issue is made worse because many available skilled workers are under-skilled in their particular trades (Akomah et al., 2020).
Regulatory resistance	This is another factor in the management of contracting companies' reluctance to train their employees in Lean Construction methods. Lean Construction procedures cause blockages that hinder employee training, particularly for foreign employees already present in the nation. Additionally, the contracting institutions were highly resistant to innovation or change, including Lean Construction, and an unfavourable procurement structure meant that only contractors were exposed to the risks associated with adopting fresh concepts.
Inadequate waste identification and management	Another impediment was identified: the absence of waste identification and management while looking at the second level of the 4 P model, which is removing waste in the processes (Cano, Botero, García-Alcaraz, Tovar, & Rivera, 2020). Detecting wastes is critical to figuring out the reasons for inefficiencies, and it also

	supports process management, produces knowledge, and improves the environment for decentralization (Viana, Formoso, & Kalsaas, 2012).
New Approaches could result in higher costs.	Financial considerations significantly influence the lean journey and the demand of time. The decision to accept a new philosophy is influenced by inadequate finances and resources, inflation, financial crises, and market conditions (Raid Al-Aomar, 2012); (Olamilokun, Yusuf, & Omopariola, 2017); (Jamil Ghazi et al., 2019); (Marhani et al., 2013). The lean implementation also demands sufficient financial resources to cover employee and professional rewards, consultant hiring, worker training, organizing seminars, and purchasing equipment (Bashir et al., 2015).

Further, the extant literature indicates that one of the main reasons for these issues is insufficiency and waste, with non-value-adding activities within the construction processes. Lean Construction emerged to minimize these non-value-adding activities which do not add any value to the final product of construction. Therefore, it is important to discuss non-value adding activities in Lean Construction Implementation. The next section presents an overview of non-value-adding activities reviewed through the literature.

2.1.3 Non-Value Adding Activities

Non-value-adding activities, often known as waste, incur direct or indirect costs and demand time, resources, or storage but do not advance the product (Gereme, 2018). Recent years have seen numerous global study initiatives on waste in the construction sector (Saadi, Ismail, & Alias, 2016); (Turkyilmaz et al., 2019); (Viswalekshmi, Bendi, & Opoku, 2022)). The productivity, timing, cost, environmental impact, and sustainability of building projects can all be negatively impacted by waste (Mahfuth, Loulizi, Al Hallaq, & Tayeh, 2019). From the beginning of a project's design through its completion or demolition, waste management operations constitute an integral part of every stage of the construction process. The amount of waste generated during construction is not the only factor to consider; other factors include overproduction, waiting times, material management, processing, storage, and labour transportation (Mbote, 2018). Defect reworks/repairs, delays, material waste, improper material allocation, waiting, material waste, and inappropriate material handling are the main kinds of waste during construction (Pertiwi, Kristinayanti, Andayani, & Indrayanti, 2018). Non-value-adding tasks are wasteful and ought to be discontinued. These non-value-adding activities are the main factor causing cost overruns, construction process delays, and other related issues (Fidelis, John, & Sangwon, 2014). Table 2-6 below summarizes the literature on non-value adding activities to recognize them in the process of construction.

Table 2-6 Non-value adding activities

Defects or rework:	In the construction industry, terms such as 'defect,' 'rework,' 'fault,' 'snag,' 'quality failure,' 'non-conformance,' and 'deviation' are used interchangeably (Mills, Love, & Williams, 2009). Rework is "the procedure when an element of building works fails to fulfill client expectations and specifications, or when a completed project does not adhere to contract documents" (Oyewobi et al., 2011). As noted in earlier studies, rework significantly contributes to cost overruns in construction projects (Mahamid, 2016). They might be emotionally charged and have various meanings to various people. Nonetheless, they consistently imply that the customer is dissatisfied with the outcome. Rework has a negative effect on how well construction projects operate (P. E. Love, Teo, Carey, Sing, & Ackermann, 2015). Rework costs are a significant factor in cost rise and schedule expansion in construction projects (Lopez, Love, Edwards, & Davis, 2010). It is a prevalent issue that hinders construction practice (P. E. Love, Edwards, Watson, & Davis, 2010). Simply put, the word "to rework" is to edit or redo anything. Many definitions of rework have been established in the literature concerning the construction, and they often revolve around the concepts of quality (i.e., compliance) and change/deviation (P. Love & Smith, 2018).
Unnecessary Waiting:	Construction delays result from unnecessary waiting (Chidambaram, Narayanan, & Idrus, 2012). Delay is when a project is delivered after the agreed-upon delivery date or past the completion deadline stated in the contract (Tafesse, 2020). The systematic inclusion of "time wastes" in various construction-related operations results in delays at construction sites (Ali & Arun, 2014). The lost time is usually productively spent on a particular task. Numerous factors lead to time-wasting in various activities. Construction time wastes are activity-focused time wastages brought on by idleness or ineffective work (Ali & Arun, 2014). The continuous accrual of time wasted at different project stages ultimately results in a significantly delayed project. Construction industry delays are a global issue that has not yet been resolved (Shahsavand, Marefat, & Parchamijalal, 2018).
Unnecessary Motion:	Activities of employees, machines, and equipment that do not add value to the work are wasted from the wasteful mobility of people and equipment (Shou, Wang, Wu, & Wang, 2020). Insufficient working environments for people, machines, and equipment, as well as inefficient work practices, are key contributors to the wasteful movement of people and equipment (Long, 2018). These operations demand more people, take longer to complete, and have lower productivity (Nimesha Vilasini, Neitzert, & Jayatilaka, 2012).
Excess Inventory	Maintaining excess inventory of raw materials, parts in the process, or finished goods. These excess resources could be used elsewhere, requires additional storage capacity and holding costs such as insurance and taxes, and finally create an unnecessary cost to the project (Forbes, 2020)
Extra Procedures	Planning and organizing pointless procedures into a single workflow or an entire project is a waste of over-processing (Uusitalo, Lehtovaara, Seppänen, & Peltokorpi, 2020). Lack of standardization and the contractor's inadequate understanding of the manufacturing process (Srinivas, 2021) are two major contributors to over-processing. Aside from wasting time and resources, over-manufacturing occasionally results in spoiled goods. Measuring material with non-standard tools, inspecting all the standard products or materials that have enough externally supplied certificates of quality, and placing elements with too large of a dimension to create, among many others, comprise some typical examples of waste from over-processing

Unnecessary Transport	Inappropriate methods for moving materials or finished items through a production flow or across a site constitute waste from wasteful transportation (Pérez & Costa, 2018). The employment of substandard equipment or poor conditions of routes is a major contributor to wasteful transport, as are inappropriate and poor site layout ideas (Pérez & Costa, 2018). These result in time loss, increased costs for labour and equipment, and an increased risk of receiving faulty products(N. Vilasini, Neitzert, & Rotimi, 2014). Transporting manufactured parts to a temporary yard, moving cement packages from site A to site B for storage, and other similar situations comprise common scenarios of waste from unnecessary transport.
Incorrect Processing	Construction method selection, implementation, and improvement (CMSII) is critical. Also, it is a challenging task for projects in the construction industry, particularly for large and complex projects that frequently face challenges like insufficient information, a complex project environment, and complexities brought on by new technologies (Ren, Shen, & Xue, 2013). These could, in turn, lead to incorrect processing, causing a waste of time and resources during construction.
Unused people creativity	Individuals' creative aptitudes reliably differ from one another. The ability to generate problems, active participation in problem production, and the presence of various contradictory inputs all impact creative problem-solving (Arreola & Reiter-Palmon, 2016). Thus, not using people's creativity in construction processes constitutes waste.
Environmental Waste:	Globally, the vast production of construction and demolition (C and D) debris has negatively influenced the environment. Each year, the renovation, building, and demolition of structures result in enormous amounts of Cand D trash (Black, van Os, Machen, & Fulop, 2021). Well, over 10 billion tons of C and D waste are produced annually, with the United States producing roughly 700 million tons and the European Union producing over 800 million tons (X. Wu, Li, Yuan, Wang, & Wu, 2019). According to (Zheng et al., 2017), China generates over 2 billion tons of C and D trash annually as a result of its rapid urbanization and extensive urban regeneration initiatives (Zheng et al., 2017). This accounts for nearly 40% of all solid waste produced globally (Zheng et al., 2017). This is because of the growing need for housing development projects, commercial buildings, and infrastructures, which has resulted in huge volumes of construction waste (Nagapan, Rahman, & Asmi, 2012). C and D waste's effects on the environment are now a global problem (N. Vilasini et al., 2014; J. Wang et al., 2018).
Behavioural factors leading to waste:	The attitudes and actions of those working in the construction sector impact its expansion and improvement. Based on the contractor's size, waste management attitudes and behaviours tend to vary. Regarding waste management, contractors with pleasant attitudes also exhibit acceptable behaviour (Begum, Siwar, Pereira, & Jaafar, 2009). However, it is critical to note that research has emphasized more on establishing approaches to strengthen the operational systems of building projects, and one such technique for betterment is Lean Construction (P. Wu et al., 2013). Lean Construction, which focuses on meeting customer expectations while employing a minimal amount of everything (Aziz & Hafez, 2013), is the consequence of applying this new production management methodology to the construction industry. Lean construction is a cutting-edge method to reduce non-value-added costs in the construction process, and the process will become "lean" with better results (Forbes, 2010). Lean operations improve the efficacy and efficiency of all processes, resulting in a sustainable operation and reducing waste (Sutrisno, Vanany, Gunawan, & Asjad, 2018). Trying to be lean involves reducing the chances of non-value-added activities by improving the capacity to discern the sources of waste.

The above section discussed the non-value activities with some examples. It is critical to note that these non-value adding activities are mostly unnoticed and intangible, and it is vital to identify how these non-value activities occurred during the construction process. Hence, the next section reveals the sources for these non-value-adding activities.

2.1.4 Sources for non-value-adding activities in the construction processes.

This section discusses the sources for the existence of non-value adding activities. According to (Alwi et al., 2002), sources of non-value adding activities in the construction processes can be divided into the following categories: people, professional management, design and documentation, material, site operations, and physical factors (Alwi et al., 2002). The research question of this study is *how to improve Lean Construction Implementation from a Human Capital perspective.* Therefore, it is significant to identify how people contribute to non-value-adding activities discussed in the above section (see section 2.1.3). Therefore, People as a source of non-value adding activities are discussed first.

People: These comprise incompetent regulators, insufficient subcontractor skills, a lack of qualified foremen and supervisors, tardy work supervision, unequal labour distribution, and many others (Alwi et al., 2002; Forbes and Ahmed, 2020). New Zealand Construction Industry Survey (2021) concluded that "without clear entry points for new workers to start jobs and gain trade skills they need before starting work. Also, NZ will struggle to develop the skilled workforce it needs to implement its infrastructure programs.

Figure 2.1 below demonstrates the construction industry's challenges to future growth, and the most critical challenge is a skill shortage and the availability of workers. New Zealand Construction Industry Survey 2021, Furthermore, this report highlights the key challenges in the New Zealand Construction industry. They are the limited connection to the school's system, high cost of training, limited supply of trainers, and lack of support for work-ready training and industry induction; new entrants and employers have vastly different expectations.

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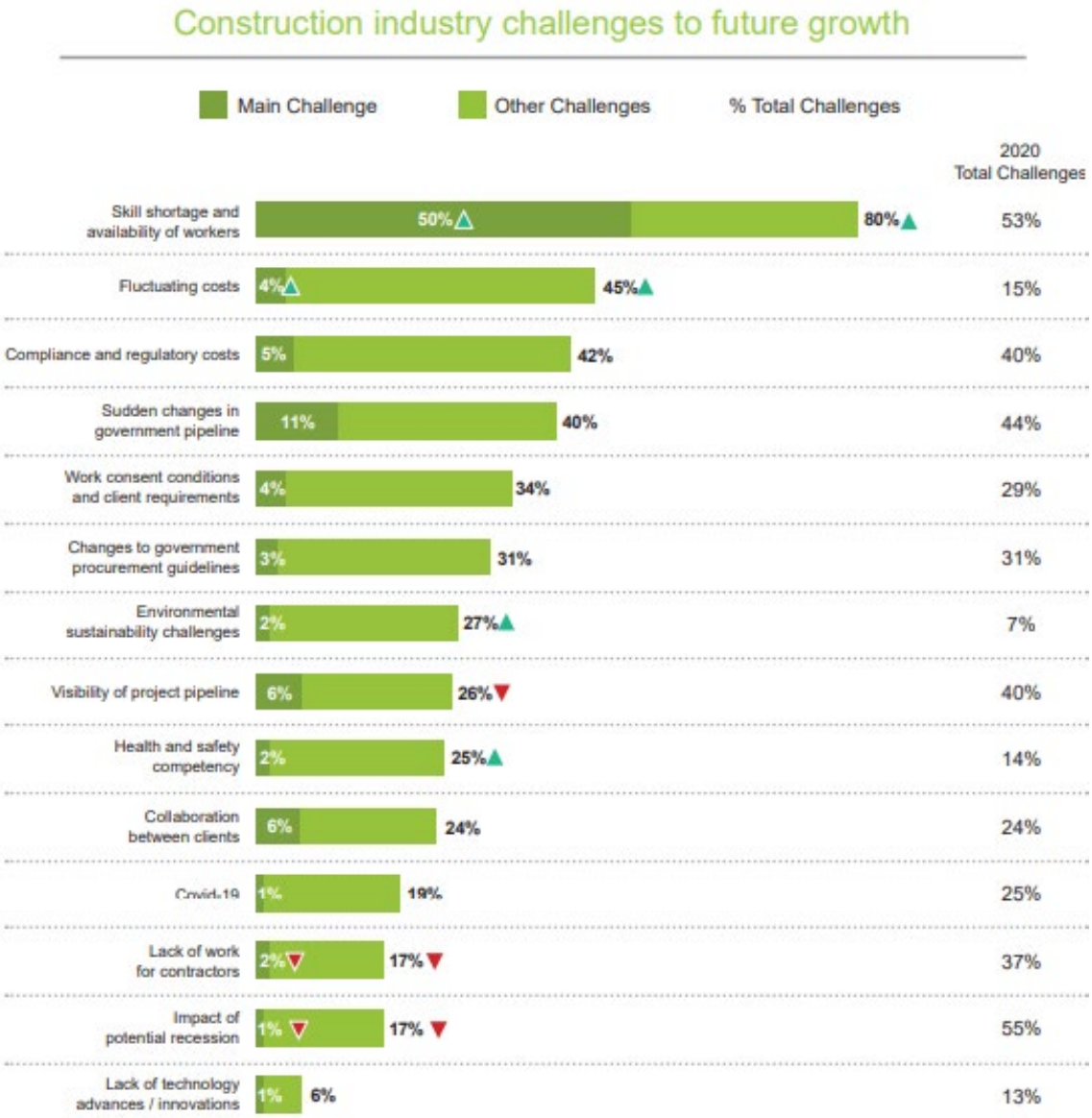

Figure 2-1: New Zealand Construction Industry Challenges (New Zealand Construction Industry Survey 2021)

In addition to the above, New Zealand Immigration (2023) states that *"there are skill shortages in New Zealand, and construction employers are having ongoing difficulty recruiting certain skills for their projects. Furthermore, it is stated that "A major international recruiting agency reports that "69% of employers say it is 'very difficult' or 'hard' to recruit Senior Managers. This is followed closely by Project Managers and Construction Managers (both 66%), Estimators (56%), Quantity Surveyors (55%), Site Managers (52%), and Project Engineers (50%). At the other end of the scale, 91% of employers say it is 'easy' or 'manageable' to recruit Cadets and entry-level candidates."* After identifying the people as one of the main

sources for non-value-adding activities, the next in table 2.7 briefly presents the other sources indicated in the literature.

Table 2-7 Sources for non-value-adding activities (Alwi et al., 2002)

Professional Management: The issues in this category include poor decision-making processes, poor construction supply chain coordination, poor information management, and poor scheduling.
Design and documentation: Subpar designs, design revisions, a late response time to a Request for Information, unclear site drawings, and confusing specifications are all examples of inadequate site documentation.
Material: Failure to meet quality requirements, delayed supply of materials, careless handling of materials, and improper usage constitute non-value adding activities relating to the material.
Site operation: This category of non-value adding activities includes poor site design, out-of-date equipment, a lack of equipment, unsuitable construction techniques, and an over-reliance on overtime to complete projects on time.

In summary, activities that do not add value are simply waste and should be eliminated. The greatest obstacle to waste removal, in general, is the failure to recognize it. Waste generated in flow activities is recognized as a major disadvantage, hindering performance and efficiency in construction activities. Lean Construction is an effort to apply lean production principles to the construction industry to eliminate non-value-adding activities in the construction processes and maximize client value. The objective one of this research is to *identify the barriers to implementing Lean Construction are.* Therefore, reviewing the Lean Construction practices before identifying the barriers to implementing them was identified as important. The following section discusses Lean Construction and its implementation in construction projects.

2.2 Lean Construction

Lean Construction emerges to minimize the non-value activities in the construction processes in the early 1990s. However, the extant literature shows that Lean Construction practices are still not mature enough, and this research targets to develop a framework to improve them. Therefore, it is significant to review the Lean Construction practices and, first, present an overview of Lean Construction.

2.2.1 Overview of Lean Construction

Lean Construction was created to address problems in the construction sector, such as a ton of trash (Koskela, 1992); (Mossman, 2015), productivity loss (Aslam et al., 2020), and environmental concerns (Ruben, Vinodh, & Asokan, 2018). It has a proven track record of being a powerful facilitator for integrating construction operations and supply chain management successfully (Dallasega, Marengo, & Revolti, 2021). Over time, certain effective Lean Construction initiatives also opened the path for increasing the effectiveness of the construction sector. (Aslam et al., 2020) show that lean methods increase the likelihood that construction projects are finished two times earlier than scheduled and three times below budget. Similarly to this, various case studies have shown that Lean Construction has reduced costs (Sebastian, 2019); (Widayat & Syairudin, 2019), decreased project timeline (Erol, Dikmen, & Birgonul, 2017), boosted productivity (Awad et al., 2021); (Ng & Hall, 2019).

Notwithstanding a solid underpinning theory and numerous effective lean-based building projects, the construction sector lacks the necessary wealth for Lean Construction (Aslam et al., 2020). Even though there is strong evidence for the benefits of lean, (Forbes & Ahmed, 2020) highlighted that it is challenging to compare the data and outcomes primarily presented by lean practitioners across projects because of geographical variances. Due to Lean Construction's broad-based terminology, which requires a detailed explanation for the broader construction sector, (Green & May, 2005) further questioned its realism and practical implementation. (Yadav, Nepal, Rahaman, & Lal, 2017) assert that the failure to explain what lean implies realistically adequately is the cause of the lack of reaction to Lean Construction.

Lean Construction is a philosophy that was developed in the early 1990s and has its roots in the lean manufacturing method. It is conceptualized by seeing construction from three points of view: transformation, flow, and value (Koskela, 1992). The main reason for implementing

lean ideas in the construction industry is to eliminate the massive waste that has already crept into its processes, materials, and flow (Sacks, 2013). Dikeman (2004) asserts that non-value-adding activities, including awaiting supplies or decisions, transporting, inspections, rework, overstock, and overproduction, account for close to 45% of labour time loss (Koskela, 1992). Since they primarily focus on the transformational viewpoint, classic management strategies like Design Bid Build struggled to handle non-value-adding tasks and satisfy customer demands(Zimina, Ballard, & Pasquire, 2012). Consequently, the construction sector began seeking Lean Construction to help it overcome its obstacles.

Lean Six Sigma on the other hand is a process improvement approach that seeks to eliminate inefficiencies in a company's process flow by identifying the causes of waste or redundancy and developing solutions to address them (S. Kumar, Kumar, Luthra, & Haleem, 2013). Six Sigma is a tool kit to achieve a nearly perfect quality, with only 3.4 defects per million opportunities. According to (Ruben et al., 2018) this is achieved using a structured approach called DMAIC (Define, Measure, Analyze, Improve, Control) to identify and eliminate causes of variation and improve processes. Lean Six Sigma is often used in manufacturing, healthcare, and service industries to improve processes, reduce costs, and increase customer satisfaction (Forbes & Ahmed, 2020). However, Lean Construction is a broader approach that extends lean principles beyond the manufacturing floor to the entire organization.

The use of Lean Construction has minimized the negative environmental consequences of the construction sector in addition to lowering waste, increasing productivity, controlling project costs, and controlling schedule and schedule changes (Aslam, Gao, & Smith, 2022). The building sector produced 548 million tons of garbage in 2015, according to (Cano, Delgado, Botero, & Rubiano, 2015), which negatively impacts the local ecosystem. Natural resources, including aggregates, cement, gasoline, bitumen, timber, and steel, are vital to the building industry.

The few existing natural resources are being progressively degraded by the over usage of such materials. Practically every project in the construction sector wastes a significant proportion of these resources, according to (Eze, Seghosime, Eyong, & Loya, 2017). Due to its enormous impact on waste reduction, lean supply chain management may assist the construction sector in improving its sustainability profile and, particularly, reducing its environmental footprint

(Sertyesilisik, 2016); (Martínez-Jurado & Moyano-Fuentes, 2014). According to (Wandahl, 2014), just 6% of the survey participants in the Danish construction sector were utilizing Lean Construction, making this adoption rate seem quite low. Corporations used lean in projects with specific goals, such as increasing customer happiness, lowering defects, decreasing inventory, slashing cycle times, cutting waste, and eliminating non-value-added tasks. Unfortunately, many of the Lean projects had a very poor success rate. According to (Ringen & Holtskog, 2013) and (Ringen & Holtskog, 2013), one in three efforts for quality management flopped. Lean efforts have a failure rate of up to 70% (Pedersen & Huniche, 2011). The main obstacles are a lack of respect for people, a lack of chances for employees to thrive, and a lack of creative problem-solving.

Contractors, subcontractors, and suppliers are all bound by contracts with the owner, architects, and engineers when working on a construction project (Broft, 2020). Additionally, these stakeholders must manage resources efficiently to see the project through to completion. By planning the architectural design, supply chain, and workflows, the lean techniques give a platform for controlling the activities of converting the raw resources into the highest-performing production system (Tupėnaitė, 2021) and (Upitis, Amolina, Geipele, & Zeltins, 2020). Lean supply chain management offers contractors, suppliers, and vendors highly transparent partnerships, mutual trust, and enduring connections to develop a fundamentally effective supply chain (Kerber & Dreckshage, 2017) and (Kerber & Dreckshage, 2017); (Vanichchinchai, 2019). Supply chain management has become a crucial component of lean delivery since it supports the lean supply and the production system's job structure (Martínez-Jurado and Moyano-Fuentes, 2014). If applied correctly, Lean C'onstruction’s use of the open supply chain management conceptual framework can help the construction sector overcome most of its issues.

Notably, even though advanced work has been done in identifying characteristics that can contribute to the effective implementation of Lean Construction, it has fallen short in offering a more practical framework to execute them during construction. It is necessary to investigate these broad-based aspects at a micro level to instill the concepts of realism and applicability. The building sector is searching for more doable and adaptable implementation solutions. For instance, it has been established that workers need to have sufficient empowerment to successfully implement Lean Construction (Aslam et al., 2020); (Shang, 2014); (Torp, Knudsen, & Rønneberg, 2018), but the lean literature provides only rudimentary explanations

of the level of empowerment for various factors such as the workforce, field managers, or even subcontractors and suppliers. It is expedient to balance standardization and flexibility to manage lean processes and procedures and prevent this conflict effectively. In the literature, there is much heterogeneity in the claimed success rates of Lean Construction. The literature on lean seems to oppose improvement objectives of any kind; in reality, businesses generally want to have some objectives they want to reach since it will boost their confidence and morale in executing that change (Regona et al., 2022). Conversely, if swift initial improvement goals are not met, the desire to use Lean Construction will wane. Lean Construction is based on the five lean principles, and these principles are discussed next.

2.2.2 Lean principles

Over many years, the manufacturing sector has served as the construction sector's permanent point of reference and a source of innovation. Lean manufacturing is an approach that the construction sector has used to boost productivity (Parvaiz, Mufti, & Wahab, 2016), 2019). Every construction operation can be broken down into two categories: conversion activities, which result in measurable outcomes, and flow activities, which connect such conversion actions during the output delivery process. Even though all operations cost money and take time, only conversion activities contribute value; thus, they should be made more efficient instead of non-value-adding flow activities, which should be decreased or discontinued based on lean principles (Klosova & Kozlovská, 2021).

According to research into these lean concepts, there is a significant amount of waste in the flow processes of building. By removing wasteful tasks, processes can become "lean" to give "more with less" resources (Kafuku, 2019). Eliminating waste, reducing pollution, and optimizing the value of the owners have all been proven to increase environmental advantages (El-Sawalhi, Majid Jaber, & Al Shukri, 2018). Toyota pioneered lean production under the direction of Engineer Ohno, who was committed to eliminating waste (Forbes and Ahmed (2020)). The term "lean" was created by the research team studying global auto production to describe the Toyota production system's ability to reduce waste and distinguish it from craft and mass types of production (Forbes & Ahmed, 2020).

As it was already mentioned, the manufacturing system's performance criteria define waste. It is wasteful to ignore a client's specific needs. Perfectionism transfers the emphasis from

improving the activity to improving the delivery system while pursuing zero waste (Saetta & Caldarelli, 2020). Likewise, the use of a lesser amount of everything than mass production comprises lean production (Tekin, Arslandere, Etlioğlu, Koyuncuoğlu, & Tekin, 2018). Furthermore, lean thinking's objectives comprise performing against perfection, including a unique tailored product, prompt delivery, and having nothing stored (Chandrakar & Jain, 2019). This condition is optimal since it optimizes value and reduces waste.

Define Value, Value Stream, Flow, Pull, and Perfection are the five guiding concepts of lean thinking (Davim, 2018). They are explained in the following Table 2-8.

Table 2-8 Lean Principles

Define Value	Understanding what value is crucial to comprehending the first rule of establishing customer value. Value is determined by how much a buyer is willing to pay (Olajide, Lizam, & Olajide, 2016). It is crucial to find the customer's latent or actual demands. Customers occasionally might not know what they want or be unable to express it. This frequently occurs when new products or technologies are involved. Numerous methods, including web analytics, demographic data, interviews, and surveys, can be used to understand and identify what customers find useful. By employing these qualitative and quantitative methodologies, it is possible to learn what customers want, how they would like the product or service, and what price they can afford. Quality, time, and cost are the values typically emphasized in the construction sector (Pollack, Helm, & Adler, 2018)
Map the Value Stream	The objective of this stage is to identify all of the actions that contribute to the client's values by using those values as a point of reference. Wasteful activities do not benefit the final consumer (Hossain, Bissenova, & Kim, 2019). Two types of waste can be distinguished: non-value added but actual waste and non-value and needless waste (Thürer, Tomašević, & Stevenson, 2017). The former should be lowered to the absolute minimum, while the latter should be eliminated because it is sheer waste. It is possible to guarantee that clients receive what they precisely want while lowering the cost of manufacturing that good or service by minimizing and eradicating extraneous procedures or phases.
Create Flow	This stage ensures that the value stream's remaining steps proceed uninterrupted and without bottlenecks after eliminating the wastes (Ikatrinasari & Kosasih, 2018). There are several ways to ensure that value-adding activities go smoothly. These are developing cross-functional departments (Fukuzawa, 2020); balancing the workload (Marangoni, Romagnoli, & Zammori, 2013); rearranging the production steps (Gottmann et al., 2013); cutting down processes (Shou et al., 2020); and teaching staff to be multi-skilled and adaptable (Adler, 2011)
Create Pull	The largest waste in every production system is thought to be inventory (Bon & Garai, 2011). A pull-based system's objective encompasses minimizing inventory and work-in-progress (WIP) items while ensuring that the necessary supplies and knowledge are accessible to support a seamless workflow (Lyly-Yrjänäinen, Holmström, Johansson, & Suomala, 2016). In other words, a pull-based system enables just-in-time manufacture and delivery, in which goods are

	made in the quantities required and at the time required. The needs of the final users comprise the starting point for all pull-based systems. It is possible to ensure that the products can meet consumer expectations by following the value stream and moving backward through the production chain (Patil, Pisal, & Suryavanshi, 2021).
Strive for Perfection	This is the most crucial phase. It integrates quality management and lean thinking into the workplace culture (Lagrosen & Lagrosen, 2019). While delivering products based on consumer demands, every staff should aim for perfection. The corporation ought to be a lifelong learner who constantly looks for ways to improve daily. Lean construction's main idea is to facilitate the flow of stages by removing non-value-added tasks that use up time, resources, or space (Radhika & Sukumar, 2017). It concentrates on process improvement by reducing the time required for each task. The idea of lean construction provides the cornerstone of project management.

As mentioned earlier, the seven keys that comprise the Lean Construction principles include value, identifying and mapping the value stream, flows, pull, precision, transparency, and process variability. Lean thinking is hinged on distinctive bespoke goods (Bhasin & Found, 2020), prompt delivery (Thangarajoo & Smith, 2015), and no storage (Sacks, 2013). The fundamental ideas of Lean Construction must be taught during the first phases of construction. The literature lists the several lean techniques used in the construction industry, and these are covered in the following section:

2.2.3 Lean Techniques

Most companies involved in the construction industry still focus on conversion operations and flow activities while ignoring value concerns (Mahamid, 2022). Lean thinking's integration with the construction sector is at the heart of the emerging idea of Lean Construction. (Natarajan & Thenmozhi, 2021) Examine the non-value-added aspects (flow, delays, and faults), and (Ahmed & Sobuz, 2019) explore the value-added element (conversion). Over the past few years, experts worldwide have become increasingly interested in examining the degree to which the Japanese model of lean production may be used in the construction industry (Chiarini & Brunetti, 2019); (Ibrahim, Imtiaz, Mujtaba, Vinh Vo, & Ahmed, 2020); M. M. Musa, Saleh, Ibrahim, and Dandajeh (2023); (Parvaiz et al., 2016). Eliminating non-value-adding activities from the construction process flow through Lean Construction is a novel application of lean production principles to the sector. (Mohammadi, Igwe, Amador-Jimenez, & Nasiri, 2022).

The initial premise of the strategy is the assertion that project teams must assist clients in making decisions rather than merely carrying out their instructions. Rahna, Wang, and Lim (2012) examined the crucial phases in the Lean Construction process. These include establishing the client's budget and determining the design requirements, goals, and limitations. According to Rahna, Wang, and Lim (2012) the construction life cycle is the ongoing practice of removing waste, concentrating on the full value chain, and pursuing excellence in executing a construction project (Forbes & Ahmed, 2020). It also emphasizes how various actions might influence one another. The entire process is organized to increase value and minimize waste at the project delivery level. Many lean approaches exist. During the past twenty years, literature has highlighted adopting these techniques in the construction process flow. The following table 2.9 summarises the widely utilized lean strategies to deliver more value with fewer resources. These techniques identified through the literature review are presented in alphabetical order.

Table 2-9: The prevalent lean techniques utilized in the construction industry.

Lean Techniques	**Description**	**Sources**
Bim Information Modelling	Building information modelling is being used more frequently in the architecture, engineering, and construction (AEC) sector because of its numerous advantages for project stakeholders, including increased productivity, improved design visualization, decreased construction waste, improved data exchanges, and better product quality	((X. Yin, Liu, Chen, & Al-Hussein, 2019)
Daily Hurdle Meetings	These are short daily start-up meetings held as a means for continuous improvement. The project team members discuss. Issues related to the progress of the work plan, as well as challenges. The tool enables members to plan ahead and address. problems before affecting project's progress	Enshassi et al. (2019), Salem et al. (2005), Aziz and Hafez (2013), Sarhan et al. (2017),
Increased Visualizations	Integrating design and building processes across disciplines and enhancing automation through visualization, virtual design, and construction has provided the construction sector with new avenues for growth.	(Aslam et al., 2022) Enshassi et. al. (2019), Babalola et al. (2018)
Kaizen	"Kaizen" refers to corporate practices that continually improve all organizational operations. It is a lean production method that reduces waste incrementally.	(Plescaci, 2022), (Jin & Doolen, 2014)
Kanban Material Card	Kanban instructs a system inside a process system to carry on with production without making any intermediary adjustments between the various stages of production. The data is presented on the Kanban system cards, demonstrating how the task is	(Karthik & Rao, 2019)

	being done. The jobs they did, the materials they needed, the resources they could need, and many additional duties are all included. In the Kanban card	
Just in Time	A " Just-in-time " system makes sure that everything is available when needed and in the appropriate quantities. This tool reduces the flow times: production times and response times.	(Patel & Patel, 2021) Aslam et al. (2022),
Last Planner System	The Last Planner Solution was created as a production planning and controlling system for the construction sector. It has been regarded as one of the most important lean strategies in the execution of construction projects because it strives to increase schedule reliability while also smoothing workflow. Through cooperation, openness, continual improvement, and dependable pledges from the Last Planners, who are ultimately responsible for seeing that the job is completed, the last planner system works to fulfill its objectives. LPS is a coherent and holistic system for planning and production control.	(Schimanski, Marcher, Pasetti Monizza, & Matt, 2020), (Poudel, Garcia de Soto, & Martinez, 2020) (Enshassi et al., 2021)
Prefabrication	Prefabrication is a development industry word that describes assemblages created in processing factories and brought to the construction site. Prefabrication, also known as prefab structures, system-built structures, or factory-build structures, is the process of fabricating and assembling structural elements, such as roof trusses, windows, doors, floor, and wall panels, and even entire building parts, based on predetermined standards in a manufacturing facility before transporting them to the construction site.	(Baghchesaraei, Kaptan, & Baghchesaraei, 2015). (Thornton, Nath, Hu, & Jia, 2019)
Relational Contracting	Relational contracting is a type of transaction or contracting process that aims to make the business relationship between the contract's parties explicit. In essence, the contract allocates duties and rewards fairly and openly, with delivery systems promoting partnership and trust. This can assist in efficient and successful construction, minimize unfavourable occurrences, and easily resolve conflicts at the project level in the construction industry. It can also increase financial returns.	(Jagtap & Kamble, 2019)
Set-Based Design	SBD is a sophisticated design methodology that calls for a change in how one approaches and controls design. The set-based design paradigm can substitute design discovery for point-based design construction, allowing more design work to be done simultaneously and postponing exact specifications until trade-offs are better understood.	(Toche, Pellerin, & Fortin, 2020)
Total Quality Management	Total quality management emerged to continuously enhance a firm's capacity to achieve quality and provide the expected output to the customer. Total quality management in construction promotes quality and productivity. To Latansa et al. (2019), Total Quality Management is a management methodology and a principle of operation that can increase a firm's competitiveness. Organizational improvements made with Total Quality Management are also more successful.	(Salihi & Ghasemlounia, 2021)

Value Stream Mapping	Value Stream Mapping aims to cut out any non-value-adding activities from the production process. It is used to determine which processes' actions offer value relative to those that do not, which opens up room for development and has a big impact on the production system.	(Gunduz & Naser, 2019) (Forbes & Ahmed, 2020)

The above table 2-9 demonstrates the different lean techniques implemented in the construction industry since 1993, when Lean Construction emerged. The research gap identified in this research is the slow implementation of these lean techniques in the construction industry. Also, it has been identified that Human Capital, skills, knowledge, and capacities of people, plays a major role in implementing lean techniques. Therefore, the key research question of this research emerged on *how to improve the Lean Construction Implementation from a human capital perspective*? Therefore, it is vital to discuss how these lean techniques are implemented during the process of construction. The following section presents the Lean Construction Implementation through a literature synthesis.

2.2.4 Lean Construction Implementation

According to (Ansah et al., 2016), lean construction entails a project delivery method based on production management that stresses the prompt and efficient delivery of value. Lean construction is a new project management approach that integrates lean thinking and lean principles from production management, which were first established in the Toyota manufacturing system in the 1945s (Forbes & Ahmed, 2020). The project must be constructed with an eye toward excellence, waste reduction, and value maximization (Ansah et al., 2016). The Lean Construction Institute has specialized in using Toyota's Lean Production approach to perform construction projects. The Lean Construction Implementation emphasizes the notion that building projects can be handled utilizing the principles and practices of lean manufacturing since they are just production systems (Vilasini et al., 2014). Lean implementation plan, lean design, lean supply, and lean assembly are all parts of the lean project delivery system (Ballard & Howell, 2003).

In the lean design phase, the conceptual design for the project is processed to create a lean product that adheres to the project's scope and design standards. The lean supply module also includes logistics for deliveries and stocks, the comprehensive details of the product design's architecture, and the production of components and materials or their purchase.

Delivering tools, materials, and parts, as well as commissioning and delivering projects to clients, are all included in lean assembly (Raid Al-Aomar, 2012). Manufacturing, design, supply, and assembly have been revolutionized thanks to lean production management. Through methodologies, Lean transforms construction work and applies those skills to a new project delivery process (Vilasini et al., 2014). The lean delivery system is thus discussed in table 2.10 below.

Table 2-10 Lean project delivery system

Lean implementation plan	Value management in lean manufacturing is an effort to maximize value and eradicate waste; hence, defining value and waste is crucial (Velmurugan, Karthik, & Thanikaikarasan, 2020). Cost, quality, time, location, and other restrictions are requirements that must be addressed to provide value to clients, as (Zid, Kasim, & Soomro, 2020) noted. Target value design is a management technique that aims to make customer constraints design priorities to offer value. Over time, the industry has employed the efficient management strategy of target costing to ensure cost predictability while developing new products. The construction sector, which is working to increase the number of favourable implementation and project delivery consistency in terms of cost, quality, and timeliness, stands to gain from adopting this method (Zimina et al., 2012). Target value design is a management strategy that applies the core qualities of target costing to the unique characteristics of the building industry. Target value design's systematic implementation has significantly enhanced project performance (Zimina et al., 2012).
Lean design	According to research (Khan, Saher, & Yunis, 2019); (Kolltveit & Grønhaug, 2004), managing the early project phases well is critical to provide value for the consumers. In reality, ineffective management of the early phases can affect value delivery and result in issues that do not surface until the end, such as cost uncertainty, delayed delivery, and poor final product quality. Lean design is one of the methods that academics have suggested to manage the design phase. In practice, the Project Definition, Lean Design, Lean Supply, and Lean Assembly stages of the Lean Project Delivery System (LPDS) model for managing projects attempt to deliver what customers need without waste (Ballard 2000). The first in the LPDS project lifecycle, the project definition phase, entails three stepwise functionalities: identifying customer needs and requirements, converting those goals into specifications for the product and design process, and producing a structural conceptual framework based on those specifications. Lean Design starts after the concepts and purpose criteria are in sync, and it seeks to match the project definition components with the product and the design process. A novel paradigm for handling design and construction is called lean design management. Lean Design Management, which applies "lean production" ideas to the design process, has been hailed as a new paradigm for improving the effectiveness of the design process and producing better-quality results. Nevertheless, it should be highlighted that this process is highly challenging to manage and frequently suffers from a lack of efficient planning and management, which would help lessen the consequences of uncertainty.
Lean supply	The construction sector is heavily fragmented and characterized by specialization within organizational roles (Tommelein, 2015), including buying (sometimes

	known as purchasing). The goal of conventional construction procurement processes has been to buy goods and related services at the lowest cost achievable. How business negotiations are managed, which nearly always decides how supply systems are designed ultimately, impedes the adoption of supply chain management principles in the construction industry. Due to the lack of emphasis on creating a continuous flow to give the most value to the ultimate customer, it is not hard to hear that "what occurs after the procurement process is a logistical problem." This points to the fact that supply systems happen; they are not specified, so they are not even designed. One of the first steps in improving how supply chains are handled should be to re-evaluate the function of procurement. Procurement teams should better understand supply trends and complexity to clarify that supply can and should be managed (people in the construction industry typically behave as if supply cannot be controlled). Controlling deliveries like site operations should be one of the objectives.
Applying Lean Thinking to the Supply Chain	The connection between the customer and the supplier is a factor that contributes significantly to a company's overall costs and plays a fundamental role in production. Considering both the projected production volume and the buyer's desire to purchase items at low prices while maintaining high-quality standards, this connection becomes contradictory. A new approach to supply-chain management is necessary to meet market needs since a successful supply chain is rapid, unified, and lean. Since there are numerous distinct suppliers, projects, and other direct (such as labour) and indirect (such as rental equipment) necessary resources, construction supply chains can get disjointed. Furthermore, standard project management technologies are commonly used to run construction enterprises. Consequently, issues with construction supply chains may be attributable to the combined effects of growing fragmentation and ineffective construction management techniques. Stock Reduction and the Just-in-Time System: JIT (Just-in-Time) is based on the idea that every action should be controlled to prevent it from occurring in a production system until it is essential. Likewise, no process material or product should be present at the production or consumption location unless it is immediately required. In other words, the demand or eventual customer must drive the whole logistical chain's output. The growing number of stakeholders, particularly at the operational stage of project execution, must negotiate enhanced decision-making capabilities within supply chains. Interfaces between suppliers, contractors, and subcontractors suggest that decisions made in the supply chain impact the final product. Based on activities relevant to a specific project, these interfaces may increase or reduce the output rate on the locations. Eliminating or reducing unnecessary actions may result from improving the "quality" of supply-chain decision-making, assuring that the completed product accomplishes intended goals.
Lean assembly	Lean assembly begins with the first delivery of resources to the site and ends with project turnover (Salem, Solomon, Genaidy, & Minkarah, 2006). Moreover, it is vital to general contractors during the construction implementation stage. Further (Salem et al., 2006) have expressed that there are approaches to Lean Assembly, i.e., Flow Variability, Process Variability, Transparency, and Continuous Improvement. When resources are delivered to the site for the first time, and the project is turned over, that phase is known as a lean assembly. Additionally, general contractors place a high priority on it at the building implementation stage.

In the above, sections 2.1 and 2.2 presented the factors affecting Lean Construction Implementation. The following section discusses w*hat are the barriers to implementing Lean construction?*

2.3 Barriers to Lean Construction Implementation

The first objective of this research (see section 1.3) is to identify the barriers to lean construction implementation in the construction industry. This objective was achieved using three different approaches. First, a detailed literature review presents in this Chapter, next a systematic literature review depicts in the next chapter, and thirdly the primary data collection in Chapter Three. The following section highlights the barriers to Lean Construction Implementation identified through the detailed literature review. Lean Construction emerged in the early 1990s, and Table 2.11 below lists the barriers identified from 1999 to 2021 by various authors who conducted research on Lean Construction Implementation.

Table 2-11: Barriers to Lean Construction Implementation

Barriers to Lean Construction Implementation	**Literature Reference**
There is a lack of interest among construction parties to sit for a weekly review meeting to solve the problems causing project plan failures.	(Tzortzopoulos & Formoso, 1999)
Time: the main difficulty is the lack of time for implementing new practices in the projects. Training: lack of training, organization: challenges to create organizational elements, Self-Criticism: lack of self-criticism to learn from errors and responding to deficiencies, low understanding of the concepts, low use of different elements, inadequate administration, weak communication and transparency and lack of integration of the construction chain	(Alarcón, Diethelm, Rojo, & Calderon, 2005)
Changing mindsets and behaviour with lean thinking becomes a challenge; to eliminate this barrier, the contractor has to offer training and recognition.	(Salem et al., 2006)
Team members are to be interested in making changes; the unfamiliarity with lean concepts, Misunderstanding of Lean concepts, Challenges to creating organizational elements, lack of self-criticism to learn errors, responding to some deficiencies, Inadequate administration, Weak communication and transparency, lack of integration of the construction chain, Negative attitude towards implementing new practices.	(Vilasini et al., 2012)
To sustain a process improvement, team members to be interested in making changes, willing to extend their joint efforts, and promote a culture of teamwork and problem-solving	(Vilasini et al., 2014)
Cultural resistance to change to 5D BIM from traditional quantity surveying techniques within integrated project delivery	(Curtis & Derek, 2015)

“People” as the main barrier, “they do not want to change from what they are,” “cultural issues” create complications, “yet another burden on the workforce,” common company philosophy, “thinking of senior management.”	(Ruan, Ochieng, Zuofa, & Yang, 2016)
Lack of awareness and understanding of lean construction. A coherent philosophy is yet to be developed for lean construction. Resistance to change with a tendency to apply traditional management concepts. Lack of understanding of customer needs, Cultural difference: organizational culture and professional motivation	(Khaba, 2017)
A lack of integrated management tools in “lean management” in construction processes, data acquisitions rely on people treatment, and exclusively paper-based data manipulation, practitioners' involvement.	(Guerriero, Kubicki, Berroir, & Lemaire, 2018)
Organizational culture, Influence of traditional management practices, Lack of committed leadership of top management, Lack of clear job specification from the client, lack of client and supplier involvement, End-user preference, use of non-standard components, Slow decision-making processes due to complex organizational hierarchy, uncertainty in the supply chain, lack of support from the government for technological advancements	(J. Sarhan, Fawzia, B., Karim, A. and Olanipekun, A., 2018),
Lack of knowledge about Lean Construction practices, Unskilled human resources, resistance to change, time and commercial pressure, lack of commitment from top management, culture, and human attitudinal issues, Fragmentation and subcontracting, Insufficient financial resources, lack of government support, Fragmentation, and subcontracting	(Bajjou & Chafi, 2018)
The findings revealed 41 barriers in Lean Construction Implementation, and the highest-ranking challenges are the lack of awareness about lean construction, lack of skills, training, and lean techniques, unwillingness to change the existing culture, lack of management commitment, fragmented and cyclic nature of the construction project and unavailing communication between all project participants.	(Shakil & Md Habibur Rahman, 2019),
Totally 27 barriers have been identified using a questionnaire survey administered to lean Construction professionals. The highest-ranking barriers were lack of ‘top management support,’ ‘misperception about Lean practices,’ and ‘lack of information sharing and integrated change control. Within this study, the barriers to Lean Construction Implementation were identified into different groups such as political, economic, technical, workforce, cultural, managerial, and communication. Results indicated that the most important barriers could be found in the socio-cultural background. The top three listed barriers are: ‘Lack of top management support, ‘misperception about Lean practices,’ ‘lack of information sharing, and integrated change control.’	(Demirkesen, 2020)
A total of 39 barriers were identified through an intensive literature review. Furthermore, these barriers were categorized into six categories: management, financial, educational, governmental, technical, and human attitude. Cultural aspects are barriers are lack of commitment to the team, difficulty in focusing the business on the customer, resistance to change arising from the fear of unknown practices and seeing the news with skepticism and pessimism. Leadership Barriers have difficulty getting support and commitment from top management, Resistance to change by the leadership, centralization of decisions, and difficulty in establishing participatory management. Insufficient knowledge of managers to	(Enshassi, Arain, & Tayeh, 2012; Enshassi et al., 2021)

manage the change process. Structural aspects Barriers are the inability to measure project progress.	
This study identified 83 potential pre-deployment barriers in the literature. Among these barriers, 65 are internal barriers which are related to cultural-24, political-18, structural-18, and leadership-5, whereas 18 barriers are related to competitive-4, economic-5, political-3, social-4 and technological environment-2	(Mano, Gouvea da Costa, & Pinheiro de Lima, 2021)

The above table 2-11 shows the barriers identified by various authors through their studies from 1999 to 2021. Analyzing these barriers further, it is revealed that there is a strong relationship to the Human Capital, skills, knowledge, and capacities of people. Therefore, the next section discusses Human Capital perspectives on the barriers to Lean Construction Implementation.

2.3.1 Barriers to Lean Construction Implementation from Human Capital perspective

Some studies carried out by many types of research in various countries have identified the key barriers to Lean Construction Implementation in the construction industry. Table 2 summarizes those barriers to Lean Construction Implementation based on the critical literature review conducted for this study. Literature from 1999 to date informs us there are barriers to Lean Construction Implementation from different perspectives, such as technical, financial, and human. Sarhan, Fawzia, Karim, and Olanipekum (2018) deduced that barriers to Lean Construction Implementation are similar in both developed and developing countries. The principal barriers are traditional practices, standardization, technological, financial and performance, and knowledge related. Moreover, (Likita & Jelodar, 2019) concluded that there is a lack of innovation drivers within construction projects. Furthermore, (Bajjou & Chafi, 2018) have also stated that there are two categories, people, related barriers (55.1%) and organizational barriers (44.6%).

Hence, it is evident that Human Capital is a key concern in Lean Construction Implementation, and there is a link between Human Capital. According to (Pasban & Nojedeh, 2016)Human Capital consists of the knowledge, skills, and capacities that people invest in and accumulate throughout their lives, and is a key element in improving the assets of an organization. Table 2.12 below indicates that most of the barriers are directly related to the skills, knowledge, experience, and capacities of people (Boohene & Asuinura, 2011; Wolfson & Mathieu, 2021). The related phrases to the Human Capital are highlighted in bold within the barriers identified, and the keyword related to the Human Capita is presented in the last column as evidence.

Table 2-12: The link between Lean Construction Implementation and Human Capital

Literature Reference	Barriers to Lean Construction Implementation	Evidence of Human Capital
Tzortzopoulos and Formoso (1999)	There is a **lack of interest** among construction parties to sit for a weekly review meeting to solve the problems causing project plan failures.	Interest
Salem et al. (2005)	**Changing mindsets and behaviour** with lean thinking becomes a challenge; to eliminate this barrier, the contractor has to offer training and recognition.	Mindsets and behaviour
Alarcon et al. (2006)	Time: the main difficulty is the lack of time for implementing new practices in the projects. **Training: lack of training**, Organization: Challenges to create organizational elements, **self-criticism: lack of self-criticism to learn from errors and responding to deficiencies**, Low understanding of the concepts, low use of different elements, inadequate administration, weak communication and transparency and lack of **integration** of the construction chain	Self-criticism: understanding integration
Vilasini, Neitzert and Rotimi (2012)	Team members are to be **interested** in making changes; the **unfamiliarity** with lean concepts, Misunderstanding of Lean concepts, Challenges to creating organizational elements, lack of **self-criticism** to learn errors, responding to some deficiencies, Inadequate administration, Weak communication and transparency, lack of **integration** of the construction chain, **Negative attitude** towards implementing new practices.	Unfamiliarity attitudes, interests, self-criticism attitude
Vilasini, Neitzert and Rotimi (2014)	To sustain a process improvement, team members to be **interested** in making changes, **willing** to extend their joint efforts, and promote a **culture of teamwork** and problem-solving	interested willing culture of teamwork
Harrison and Thurnell (2015)	Cultural **resistance to change** to 5D BIM from traditional quantity surveying techniques within integrated project delivery	resistance to change
Ruan et al. (2016)	"**People" as the main barrier,** "they **do not want to change** from what they are," "cultural issues" create complications, "yet another burden on the workforce," common company philosophy, "**thinking** of senior management."	Want to change people is the main barrier. thinking
Khaba and Bhar (2017)	Lack of **awareness and understanding** of lean construction. A coherent philosophy is yet to be developed for lean construction. **Resistance to change** with a tendency to apply traditional management concepts. Lack of **understanding** of customer needs, Cultural difference: organizational culture and professional **motivation**	awareness understanding resistance. culture motivation
Guerriero et al. (2017)	A lack of integrated management tools in "lean management" in construction processes, data acquisitions **rely on people treatment**, and exclusively paper-based data manipulation, practitioners' involvement	rely on people. involvement
Sarhan et al. (2018)	Organizational **culture, Influence** of traditional management practices, Lack of committed leadership of top management, Lack of clear job specification from the client, lack of client and supplier involvement, End-user preference, use of non-standard components, Slow decision-making processes due to complex organizational hierarchy, uncertainty in the supply chain, lack of support from the government for technological advancements	culture, influence commitment

Bajjou and Chafi (2019)	Lack of knowledge about Lean Construction practices, **Unskilled human resources, resistance to change, time and commercial pressure**, lack of commitment from top management, culture, and **human attitudinal issues**, Fragmentation and subcontracting, Insufficient financial resources, lack of government support, Fragmentation, and subcontracting	resistance to change. pressure attitudes
Shakil, A., & Md Habibur Rahman, S. (2019)	The findings revealed 41 barriers in Lean Construction Implementation, and the highest-ranking challenges are the lack of awareness about lean construction, **lack of skills, training, and lean techniques, unwillingness to change the existing culture**, lack of management commitment, fragmented and cyclic nature of the construction project and unavailing communication between all project participants.	awareness skills training unwillingnes s
S. Demirkesen, N. Wachter, S. Oprach and S. Haghsheno(20 19)	Totally 27 barriers have been identified. The highest-ranking barriers were lack of 'top management support,' **'misperception about Lean practices,'** 'lack of **information sharing,** and integrated **change control**. Within this study, the barriers to Lean Construction Implementation were identified into different groups such as political, economic, technical, workforce, cultural, managerial, and communication. Results indicated that the most important barriers could be found in the socio-cultural background. The top three listed barriers are: 'Lack of top management support, 'misperception about Lean practices,' 'lack of information sharing, and integrated change control.'	misperceptio n sharing change control
Enshassi, A., Saleh, N., & Mohamed, S. (2021)	A total of 39 barriers were identified through an intensive literature review. Furthermore, these barriers were categorized into six categories: management, financial, educational, governmental, technical, and **human attitudinal.** Cultural aspects Barriers are Lack of commitment to the team, difficulty in focusing the business on the customer, **resistance** to change arising from the **fear** of unknown practices and seeing the new with **skepticism and pessimism**. Leadership Barriers are difficulty getting **support** and commitment from top management, Resistance to change by the **leadership**, centralization of decisions, and difficulty in establishing participatory management. Insufficient **knowledge** of managers to manage the change process. Structural aspects Barriers are the inability to measure project progress.	Human attitudinal. commitment resistance fear knowledge inability
Mano, A. P., Gouvea da Costa, S. E., & Pinheiro de Lima, E. (2021)	This study identified 83 potential pre-deployment barriers in the literature. Among these barriers, 65 are internal barriers which are related to **Cultural**-24, Political-18, Structural-18, and Leadership-5, whereas 18 barriers are related to competitive-4, economic-5, political-3, social-4 and technological environment-2	Cultural barriers

The above findings reveal that Human capital has a more significant influence on implementing Lean Construction, and it is vital to explore the value of the human in terms of skill, knowledge, and experience, which is the Human Capital in Lean Construction Implementation. Through this study, it was revealed that there is a strong link between the barriers to Lean Construction Implementation and Human Capital, which is discussed in Section 2.4. However, before

discussing this link, it is significant to define Human Capital in Lean Construction Implementation, and the below section presents the literature on Human Capital concepts.

2.4 Defining Human Capital Concept in Lean Construction Implementation

First, it is vital to define the 'Human Capital' using the extant literature.

2.4.1 Definition of Human Capital

Human Capital is described as the "knowledge, skills, and capacities of persons that have economic worth to an organization" (Boohene & Asuinura, 2011). However, the Organization for Economic Cooperation and Development (OECD, 2001) defines it as "the knowledge, qualities, abilities, and traits embedded in workers that permit the production of personal, societal and economic well-being." Human capital is also described as "functionalities, understanding, expertise, and experience, all embedded in and inseparable from the individual" (Dess & Picken, 2000). Human capital development is a real and unavoidable path to producing ideas for restructuring, inventiveness, quality, quality enhancement, and other essential elements needed to thrive in the corporate world in a climate of rapid change and harsh competition (Kesti, 2015). The Lean Manufacturing Environment's central tenet is human capital. Growth and a competitive edge are made possible through empowering the employees. A firm's human capital is its sole genuinely appreciating asset (Fleetwood, 2010). Workers nowadays expect to be involved with their intellect, heart, and psyche to feel empowered and successful — to learn, participate, and develop to achieve job satisfaction (Vidal, 2007). With notable success stories like Toyota and Pella, the Lean Process has matured recently (Wolfson & Mathieu, 2021).

The organization's key competencies represent human capital at the institutional level(Díaz-Fernández, López-Cabrales, & Valle-Cabrera, 2014). Although the various levels of analysis (individual, organizational, and national) are typically treated individually, each has a different outlook (e.g., expertise at an individual level; qualifications at a national level). Eventually, human capital alludes to individuals and their knowledge and skills: human capital is thus encapsulated in the people that make up the labour force. At the level of organizations, sectors, and nation-states, human capital assessment represents an accumulation of those individual skills (Romanov, 2021). However, this accumulation is not a straightforward process

of addition and requires consideration of the social capital exemplified in human interactions as well as the systems and procedures in which those interactions occur.

Human capital has a substantial influence on growth, according to Bassanini and Scarpetta's research from 2002. To prevent an imbalanced labour market and the "crowding out effect," human capital must complement the economic structure. While it is false to assume that having a larger percentage of educated professionals will inevitably result in a knowledge-intensive economy, having an educated labour force is needed but not enough. Human capital as an economic concept needs to be taken seriously to maintain sustainability and thrive in a cutthroat knowledge-based economy (Mohamed, Ari, Al-Sada, & Koç, 2021). By investing in people via training and education to increase a worker's capacity for successful work, a company may accumulate its workers' knowledge, skill, and aptitude, which can improve performance and help explain the relevance of labour maximization. Human Capital has also been used in many areas of human resource development, including learning organizations(Al-Tit et al., 2022), (Al-Tit et al., 2022) . Many practitioners have seen their profitability double or triple by utilizing Lean Leadership methods without significantly increasing their investment. This reawakening demonstrates how crucial it is to value the human aspect, which is essential to the Lean Process.

Full involvement of employees, holistic perspective of the operation, constant recognition and rewards, and dedication to innovative behaviour and synergy across the board are key Lean tools for managing employees (Wood, 2020). Several tools are available today in lean manufacturing to motivate and enliven employees. They are urged to reason, cut out waste, and look for methods to create value (Pedo et al., 2021). They must be convinced that when the business thrives, they will also. The empowerment from being encouraged to speak out helps people closest to the process identify and resolve issues, fostering a "Continuous Improvement" culture throughout all processes. According to (Edmondson & Harvey, 2018), the suggested course of action is to begin by fostering trust via collaborative issue-solving, followed by incorporating knowledge of room for improvement into one's routine on a production floor. As a result, a conforming staff transforms into a fully involved workforce. The primary means of implementing this engagement is leadership. Time and time again, mentorship, training, and team building are the most efficient catalysts for good change (Vilasini et al., 2014). The Lean Leader consistently encourages employees to participate by exposing those who thesis to him to the whole system, from the beginning to the end of the value chain (Grewan, 2018). This

activity's main gain will be the identification and advancement of fresh talent and future leaders.

According to Wood (2020), in this process, rewards and recognition are crucial. Unquestionably, praising the collective above the individual fosters team spirit. It is ideal for recognition when it is not directly related to the "bottom line." Nevertheless, the well-known "Gain Share" system, in which the firm's profit increase is split among the corporation and its staff, has also been shown to be a highly motivating method. A firm's need for human capital cannot be overstated or ignored (Wood, 2020). Lean is a recipe for improving quality. Thus, it makes sense always to be mindful of the "condition of the staff" and how engaged, empowered, and integrated it is. Attitudes and wants must be watched over and modified to keep in touch with the psychological makeup of a firm's personnel (Kim & Go, 2020). The aim of this research is to develop a framework to improve Lean Construction Implementation from a Human Capital perspective, and it is significant to identify the Human Capital theories and concepts developed in the recent past. Therefore, the next section summarizes the concepts of Human Capital.

2.4.2 Human Capital concepts

Human and intellectual capital are viewed as regenerating resources and products. To increase their innovative thinking, firms operate to foster these sources. Occasionally, a company issue calls for more than new equipment or additional funding (Dwivedi et al., 2022). Overreliance on human capital might have a drawback since it is transferable. Employees are always the owners of human capital, never employers. Grewan (2018) stated that human employees are not structural capital equipment and can quit a business.

The human capital concept posits that individuals usually behave logically and deliberately and separate economic operations from social activities, almost as if the economy were a distinct universe outside of society itself (Wood, 2020). This viewpoint obscures much of the complexity of human behaviour and social connotations. The human capital concept aims to make broad claims; it is not interested in providing more detailed or precise explanations of less widespread occurrences.

Aspects of human behaviour can be identified (Snell and Dean, 1992; Becker, 1964; Tsang, Rumberger, and Levine, 1991) and these aspects are stated in the below table 2.13 as follows.

Table 2-13 Aspects of the Human Capital

Emotion-Based	When it comes to evaluating human behaviour, emotions are significantly vital. Even when individuals are unaware of it superficially, many behaviours and judgments people make in life are emotionally motivated. Individuals may be more risk-taking and open-minded and exhibit other desirable behaviours while experiencing happy emotions. Similarly, a bad mental state can cause devastation, loneliness, or someone to decide to withdraw. Even when other circumstances are present, nearly every human conduct may be linked to an emotion of some kind.
Attitude-Based	Individual attitude significantly affects behaviour like personality and interests do. Based on an individual's growth or external influences, attitudes might be right or bad. However, an individual's attitude undeniably affects their decisions, interactions with others, and, to put it simply, their overall human behaviour. An optimistic outlook might help somebody be more open and welcoming to a specific circumstance or person. Similarly, different mindset makes people shun or block off what they see negatively.
Interest-Based	An individual's level of interest strongly impacts human conduct. Not everyone acts in a way that is inconsistent with whom they are, depending on their interests. In addition, whether or not someone takes risks or works toward a goal is frequently influenced by interest. Generally, people are more inclined to listen than they would otherwise when intrigued by someone or something. Understanding a people's level of interest in a subject may be a very effective approach to anticipating or theorizing future human behaviour
Personality-Based	People's personalities significantly influence how they behave. While some people are accommodating and carefree, others may be unpleasant and aggressive. Most of the time, it is hard to ascertain someone's personality immediately. Understanding them requires communicating with them; this typically takes time. Numerous variables might influence someone's character; some dispositions are warmer than others. Various factors, including culture, upbringing, and peers, may influence a person's personality

The next section presents the underlying causes and origins of the Human Capital aspects related to the construction industry.

2.4.3 The Underlying Causes and Origins of the Human Capital

In the previous section, Human Capital was defined, and the related concepts were discussed. The aim of this research is to *develop a framework to improve the Lean Construction Implementation from the Human Capital perspective*. Therefore, this section will discuss how these Human Capital concepts are related to the construction settings. Furthermore, this section will examine the causes and origins of the behavioural barriers under the following subheadings with reference to the construction industry. These include fragmentation and subcontracting,

Fragmentation and Subcontracting

Construction is a dynamic and complicated industrial sector. The construction organization generally includes planning, design, building, and maintenance tasks. The construction business involves numerous actors at different phases. The stakeholders, namely the contractor, designer, client, and manufacturer, are involved from the beginning to the end of the project. The sequential nature of traditional construction project delivery practices contributed to several fragmentation-related issues, including professional isolation and a lack of cooperation between design and construction (Mohd Nawi et al., 2014). Moreover, Construction fragmentation and subcontracting reduce stakeholders' motivations to collaborate and learn from one another (Mossman, 2009). These stakeholders have various conditions and commitments, but they all share the same desire to finish the associated project effectively (Alamri, 2019). Hence, starting the partnership and integrated teamwork process is imperative and developing good communication between all parties (Kozlowski & Ilgen, 2006). This is because ineffective communication will impair the system's project delivery and coordination efficiency throughout the implementation of the Lean Construction ideas. Construction sector fragmentation results from two aspects of the conventional construction phase: the building work process, where the separation of the design and construction phases causes the most notable divide, and the construction structure itself (Mohd Nawi et al., 2014).

According to (Kshaf, Mohamed, & El-Dash, 2022), The most significant causes of interface issues with subcontracting in the construction sector include contractor's financial issues, delays in contract progress payments, non-compliance with contract terms, non-compliance with the subcontractor's time schedule, lack of construction quality work, assigning aspects of the projects to a new subtractor without notifying the original subcontractor. Other factors contributing to interface issues included working on multiple projects with the contractor, climate, and geological factors (Enshassi et al., 2021).The above section discussed subcontracting as a Human capital source, and next, the procurement and contract issues are discussed.

Procurement and Contract Issues

Classical acquisition strategies and contracts could create collaboration among the project's participants that are counterproductive to success (Mossman, 2009), impede the use of lean concepts, add redundant operations, and slow development. Contract clauses give one player the power to rule over another, which leads to adversarial relationships. These

aggressive connections create high transaction costs that contravene lean principles (Alamri, 2019). Establishing a collaborative culture that stresses a clear connection between the design and construction processes is fundamental to successfully advancing Lean Construction practices (Alamri, 2019). Many of the challenges in construction projects are related to inefficient procurement processes where the priority is on a short-term individual sub-optimization and not on long-term project team performance (Kiani Mavi et al., 2021),. Moreover, Kong and Gray (2012) asserted that the traditional procurement processes are too slow. The authors claim that the continual nature of the many process phases and stages, particularly the division of the design and building phases, are some of the factors slowing down the process. The regularity of alterations, with design and scope modifications being a primary source of unhappiness, is the most significant cause of the delays brought on by arguments between the different parties. contract issues in the construction industry are a result of economic, governmental, and regulatory requirements. Also, the issues with the tender documents (contracts, drawings), contract parties' specifications, and material adaptation (quality), natural environment, sector environment, technology use, arbitration, and grievance redressal, as well as career ethics (Dmaidi, Dwaikat, & Shweiki, 2013).

Subcontracting and procurement issues were discussed in this section. Next, education-related concerns are presented below.

Education-related concerns

Even while professionals, scholars, experts, and professional bodies from various nations have made some efforts to spread information and training regarding Lean Construction, it indicates that pedagogical barriers may still threaten the adoption of Lean Construction (Kiani Mavi et al., 2021). Among them include a dearth of specialist knowledge, a lack of training, a contempt for creative human resource management and development, low perception and alertness, inadequate teamwork abilities, incompetence, and computer illiteracy (Alamri, 2019), (Mossman, 2009). Insufficient knowledge of or comprehension of lean principles "Notions from manufacturing lean thinking are being applied to the construction industry (Eriksson, 2010). As a result, many perspectives on Lean Construction are directly tied to lean manufacturing. There is contention concerning how lean methods should be used in Lean Construction (Green, 1999). Since some lean production techniques may not widely apply in the construction industry, its users in the construction sector must modify and adapt the concept to suit the construction sector.

Alamri (2019) proposes that lean manufacturing concepts must first be adequately comprehended before the underlying philosophy of Lean Construction can be thoroughly understood. Numerous investigations have also noted that the biggest hurdles to implementing Lean Construction include introducing the requirement of integrating Lean Construction and the challenges in determining its conceptual framework. It might be due to the absence of a detailed, widely accepted understanding of lean concepts. According to (Alamri, 2019), the ideal way to develop insight and knowledge is to consider its key aspects, such as collaboration, as an indication of creative management strategies. Implementing new tools for the building sector that clearly differ from those utilized in conventional procedures were also established by Lean Construction. These disparities must be contemplated before these tools can be used to their highest capacity, as (Alamri, 2019) pointed out. According to numerous experts, lean requires broad system-wide attention in addition to various cognitions, teamwork, adaptability, dedication, and commitment (Aslam et al., 2020),; (Mossman, 2009); (Bertelsen, Henrich, Koskela, & Rooke, 2007). For the promised benefits of lean adoption to be fulfilled, it must encompass the entire value chain and business; any fragmented efforts risk creating more waste.

Overall, it was found that construction education—which emphasizes the fundamental elements of planning, design, and building—has a number of issues, including issues with teaching methods, competence requirements, curriculum, accreditation, evaluation, resources, and the educators themselves (Rieckmann, 2013)(Rieckmann). The majority of the concerns stemmed from the assessment of competency gaps and the curriculum design when contrasted to the particular construction management education per se (Mohammadi et al., 2022).

The above literature findings reveal that the educational-related concerns are significant in Human Capital in lean Construction Implementation. Next, the lack of dedication and backing from the top management is discussed below as a source for Human Capital area.

Lack of dedication and backing from the top management

Senior management is critical to benefitting from Lean Construction and implementing a successful strategy. Higher management must devote enough time and money to developing an efficient plan to update management and incorporate fresh Lean Construction ideas. However, a major barrier to advancing the goals of Lean Construction is top management's

failure to exert true leadership (Alamri, 2019; Alinaitwe, 2009). Contrarily, middle management, instead of the upper ranks of corporations, is the most significant barrier (Mossman, 2009). One of the significant issues in effectively applying Lean Construction principles is the propensity of construction enterprises to rely on conventional, backward-looking thoughts regarding productivity and management (Alamri, 2019). According to Common (2000), production problems are frequently only revised after a catastrophe. Because of this, Mossman (2009) cautions businesses against waiting until a crisis to act, as it might be too late to adopt new strategies and modes of thought. Regardless of the reality that these changes will massively boost their bottom line and improve quality and output standards, AlSehaimi et al. (2014) underscore that construction endeavours' propensity to hold fast to their current management concepts when they are oblivious to improved ways of achieving their planned goals will make them resistant to change.

An inadequate grasp of the demands of the consumer and a lack of customer focus

Issues in the lean transformation emerge from failing to grasp lean as a mindset that emphasizes the values and demands of the customer (Pekuri et al., 2012).

It has been stated above that the issues in the lean transformation emerge from failing to grasp lean as a mindset that emphasizes the values and demands of the customer (Pekuri et al., 2012). Specifically, in the construction sector, assessing performance in the context of time, cost, and adherence to rules is pretty pervasive, but there is relatively minimal emphasis on evaluating customer satisfaction (J. Sarhan, Fawzia, B., Karim, A. and Olanipekun, A., 2018). Moreover, the majority of construction enterprises lack the critical tools to analyze and assess the demands of consumers (Niemi & Lindholm, 2010). However, a robust customer-centric approach is vital for competitiveness (Pekuri et al., 2012) and sustainability (Gao & Low, 2014). According to J. G. Sarhan, Xia, Fawzia, & Karim (2017) ; Khaba (2017); Bashir et al. (2015); Olamilokun et al. (2017), the poor comprehension of customers' expectations and the lack of customer focus hampers lean construction implementation, particularly total quality management as Haupt (Haupt & Whiteman, 2004) noted. Another impediment to Lean Construction implementation is that it brings about less accurate project specifications (Olamilokun et al., 2017).

Next, insufficient lean knowledge and comprehension are discussed.

The insufficient lean knowledge and comprehension

Every new idea must surmount more than just objections to change; in some instances, the lack of understanding inhibits others from embracing it. Reduced levels of exposure to, knowledge of, and comprehension of Lean Construction in both developed and developing nations (Gao & Low, 2014), (Raid Al-Aomar, 2012) (Abidin, 2010); Madsen et al. (2016); Raghavan et al. (2014); Kanafani (2015); Olamilokun (2015) (Martins, Affonso, Tamayo, Lamouri, & Ngayo, 2015), (Pedo et al., 2021) (Seadon & Tookey, 2019). This is not surprising. According to some studies, the main issue impeding Lean Construction implementation is caused the inappropriate use of Lean Construction tools, and case studies have revealed that this is frequently the case (Wandahl, 2014).

Change resistance in the management

Lean does not only entail gaining new skills or deploying new technology; it also involves altering people's attitudes and behaviours and the corporate culture (Keiser, 2012 cited (Aij, Visse, & Widdershoven, 2015); Gao and Low, 2013). Like every other sector, change resistance is among the most well-known peculiarities of the construction industry (Bertelsen et al., 2007); (Forbes & Ahmed, 2020). In the construction industry, where change resistance is among the most well-known idiosyncrasies of this industry (Bertelsen et al., 2007), most businesses would instead stick with conventional management methods (Alamri, 2019) and reject novel ideas from other sectors. Individuals are more comfortable with seeing things change than changing their actions. Consequently, several studies (AlSehaimi et al., 2014; Hamzeh, González, Alarcon, & Khalife, 2021; J. Sarhan, Fawzia, B., Karim, A. and Olanipekun, A., 2018; Wandahl, 2014) stated that resistance to change was among the most significant challenges to implementing lean. Most studies on obstacles relating to Lean Construction Implementation underpinned such issues using phrases like "management resistance to change" (Gao & Low, 2014), "fear of change"(Enshassi et al., 2021), "resistance to change by managers" (Cano et al., 2020), "organisational inertia resists change" (Porwal, Fernández-Solís, Lavy, & Rybkowski, 2010). Moreover, these phrases are "behavioural change" (Mastroianni & Abdelhamid, 2003); (Salem et al., 2006), "ignorance to change" (Senaratne & Wijesiri, 2008), "wrong attitude to change" (Olatunji, 2008); (S. Sarhan & Fox, 2013), and "this is how we have always done it" (Porwal et al., 2010).

According to the literature review, ‘culture and human attitudes’ and ‘absence of long-term thinking’ are also sources for Human capital, and the next section discusses culture-related attitudes and absence of long-term planning.

Issues with culture and human attitudes

According to research by Mossman (2009) and (AlSehaimi et al., 2014), entities involved in the construction process exhibit reluctance, a lack of self-evaluation, a lack of teamwork, a covert mentality, and weak lines of communication. It was highlighted earlier that entities involved in the construction process exhibit reluctance, a lack of self-evaluation, a lack of teamwork, a covert mentality, and weak lines of communication (Mossman, 2009); (Alamri, 2019). These authors discovered that cultural barriers made implementing a robust model for determining qualified subcontractors and employees difficult.

Absence of long-term thinking and planning

Lean adoption is a complex process that requires long-term thinking and preparation. The Liker-developed 4 P model's underpinning was the long-term concept (2004). The long-term perspective entails making decisions based on long-term aims, even if doing so entails compromising immediate financial objectives (Liker, 2004). According to (Forbes & Ahmed, 2020), the unavailability of a long-term ideology and long-term planning shift enterprises' priority from the value of their customers and diminish top management support and commitment (Bashir et al., 2015). The construction sector's dynamic nature makes adopting the Lean methodology challenging for industry practitioners (Demirkesen et al., 2022). Industry professionals may not believe they would profit from using Lean techniques, which makes implementing lean difficult owing to time and financial constraints (Ogunbiyi, 2014); (Shang, 2014).

The underlying causes and origins of Human Capital are identified as essential titles to review under the literature review, and the base factors were presented accordingly. Moreover, there are other concerns such as ‘lack of stakeholder participation,’ ‘poor management and lack of leadership abilities’, ‘poor professional pay’, ‘fear of new procedures poor delivery performance’. These sub-titles are discussed in the following section.

Lack of stakeholder participation

Lack of stakeholder participation and openness, erroneous and inadequate designs, a failure to implement the idea of design constructability ((Kim & Go, 2020), and project participants' unwillingness ((Regona et al., 2022) to share risks are the contributing factors for the origin of the Human Capital Unlike conventional building management, Lean Construction perceives collaboration amongst all stakeholders as essential to achievement rather than viewing construction as a series of discrete processes (Koskela et al., 2002) (Jorgensen, Emmitt, & Bonke, 2004). According to numerous studies (Hosseini et al., 2016; Pheng & Hou, 2019; (Spang & Riemann, 2014), these tools have proven their efficiency in various ways. This includes improving the working environment, improving customer satisfaction, having a more reliable design that is closer to field conditions, limiting change orders and dispute, minimizing variability, and having accurate pricing. Nevertheless, adopting lean tools is impeded due to incomplete and inaccurate design, as well as not involving contractors in the design stage, the lack of transparency, cooperation and involvement among stakeholders (AlSehaimi et al., 2014); (Marhani et al., 2013); (Aziz & Hafez, 2013); (Cano et al., 2020); (Bashir et al., 2015); (Hamzeh, González, Alarcon, & Khalife, 2021); 2016; (Porwal et al., 2010); (Olamilokun et al., 2017), and the project stakeholders' reluctance to share the risks (Olamilokun et al., 2017). Lack of stakeholder participation could be due to the lack of transparency in monitoring and evaluating construction project delivery, lack of knowledge and understanding, and the non-allocation of time for them to participate in the projects' monitoring and evaluation (Jadidoleslami, Saghatforoush, Heravi, & Preece, 2018). The lack of executive contractors at the design's early stages and the designer's poor executive information diminishes the plan's capacity, duplications, and additional time and costs (Jadidoleslami et al., 2018). Next, poor management and lack of leadership abilities are discussed.

Poor management and lack of leadership abilities

According to numerous investigations (Cano et al., 2020; Olamilokun et al., 2017; Porwal et al., 2010; Gao & Low, 2014; Wandahl, 2014), the willingness to change is impacted by a lack of management skills and inadequate leadership. Aziz & Hafez (2013) claim that good leaders are crucial to launching the lean journey and that a lifelong learning mindset is necessary to keep it going. Additionally, Liker (2004) names one of the tenets of the people/partner in the 4 P model as developing leaders who comprehend the task, reflect the culture and mentor others. Great leaders empower people to participate in their work and modify their behaviour, maintain

the culture of change, spread positivism, and increase enthusiasm for continual improvement whether they are in management or on the job (Ringen & Holtskog, 2013); (Pekuri et al., 2012); (Hamzeh et al., 2021).Furthermore, if a project manager lacks a clear vision, its completion will cost more and be delayed. The lack of effective communication, coordination, and the capacity to manage a wide range of risks comprise some of the causes of poor leadership abilities (Abd El-Karim et al., 2017). Next, poor professional pay is discussed.

Poor professional pay

Poor professional pay, lack of incentives, and a lack of desire: The process of transformation is impacted by a lack of professional drive (Khaba, 2017). Furthermore, a crucial idea of Lean Construction, business re-engineering, is impacted by a shortage of engaged specialists (Alinaitwe, 2009). Also, according to Aziz & Hafez (2013); Forbes & Ahmed (2020), three different sorts of employees exist in any firm. The first category includes motivated individuals actively trying to accomplish and instigate job changes. The second category consists of workers eager to find new methods to enhance their job but does not take concrete actions or make genuine attempts. Those uninterested in enhancing the work are the third kind. The first kind is called champions, and each institution only has a small number.

The effectiveness of several lean initiatives was largely due to those champions, which helped overcome the obstacles to implementing Lean Construction (Hamzeh et al., 2021). As one tactic for successful adoption of Lean Construction (Bashir et al., 2015). advised increasing workers' engagement and empowerment and offering incentives rather than expecting them to perform effectively and creatively for their regular pay. Additionally, according to (Albalkhy & Sweis, 2021), providing workers responsibility, encouraging their experience input, and motivating them can increase the use of error proofing and constant improvement. One of the leading causes of the high turnover rates among construction professionals has been unfair wage practices that do not consider the demands of the workforce (Forbes & Ahmed, 2020). Next section reveals the findings on fear of new procedures and reluctance to change among employees.

Fear of new procedures and reluctance to change among employees.

In Lean Construction, staff participation is crucial, primarily when using tools like the last planner (Ballard, 2000). Bottom-up management is necessary for addition to top-down management and tactics for achieving a lean culture in firms (Albalkhy & Sweis, 2020). In

addition, having tools does not mean anything if no one wants to use them (Johansen et al., 2004). The inability of the workforce to adapt to the new production system, new interpersonal dynamics, and changed expectations for their output and job quality can all be ascribed to the fear of change (Bashir et al., 2015); (Gao & Low, 2014). The dread of new processes is exacerbated by technology constraints, a lack of genuine organizational commitment, exorbitant prices, weak safety culture in the construction sector, and privacy and data security worries (Yap, Lam, Skitmore, & Talebian, 2022). Since Lean practice is a recent development in the construction sector, implementation rates are lower than practitioners anticipate. A primary cultural obstacle is resistance to change, which typically arises from the cultural background (Alefari et al., 2020), (Jadhav, Mantha, & Rane, 2014), (S. Kumar et al., 2013), (Ogunbiyi, 2014), (S. Sarhan & Fox, 2013), (Shang, 2014). Lastly, delays in the delivery of the materials and poor delivery performance are discussed to conclude the underlying causes and origins of the Human Capital.

Delays in the delivery of the materials and poor delivery performance

According to Oshungade (2016), rework due to errors during construction, unacceptable quality of materials, delay in delivering materials, delay in approving changes in the project scope, insufficient contractor's experience, inadequate and unclear drawing details. Furthermore, Oshungade (2016) identified unexpected ground conditions, delay in client's decision-making process, shortage of equipment and labours, errors and discrepancies in design documents, delays in issuing working drawings, ineffective planning and scheduling of the project, poor communication between parties, as the reasons for delays during construction. (Kikwasi, 2012) noticed the delays such as design changes, poor project management, funding issues, information delays, delays in payments to contractors, disagreement on the valuation of work done, compensation issues. Furthermore, they identified the causes for delay as bureaucracy, supply/procurement issues, project schedule changes, conflicts among involved parties, incompetent contractors and multiple projects by contractors encompass causes of construction delays. He also added that skills unavailability/shortage, shortage/lack of equipment, poor understanding of the project, government interference, contractual claims, acts of God, idling resources, negative social impact, poor work quality due to hurry, bankruptcy, acceleration losses, stress on and contractors also contribute to construction delays.

In the above section, the underlying causes, and origins of Human Capital related factors in the construction sector were discussed. It is evident that skill, knowledge, attitudes, and experience

and capacities are directly related to the efficiency and productivity of the construction activities. Next, the importance of developing the Human Capital in Lean Construction Implementation is discussed.

2.4.4 Human Capital Development in Lean Construction Implementation

The success of the construction industry is firmly related to the effectiveness of its Human Capital (Aliu & Aigbavboa, 2019). According to (M. N. Mohd Nawi, N. Baluch, & A. Y. Bahaudin, 2014a), the fragmentation process in conventional contracting practice makes it harder for contractors to share their construction expertise, reducing their ability to influence design choices. Scheduling issues, delays, and disagreements throughout the building process might occur due to design professionals neglecting to anticipate how a contractor would build the specified project (Mohd Nawi et al., 2014).

Poor project management in the construction industry can have several detrimental implications on project length and completion. For example, it hinders the project's development, delays delivery or raises costs, and occasionally provides subpar construction (Gajewska & Ropel, 2011). Project length problems and construction delays are commonly blamed for turning profitable endeavours into losing ones. Inappropriate organizational structures cause a lack of enthusiasm, ineffective site management, poor site management, wrong planning, unclear project scope, poor communication, and subpar contracts (Gazder & Khan, 2018).

Numerous devastating catastrophes that have led to the death of people on the job and injuries to onlookers and the general public were caused by design flaws (S. Musa & Obaju, 2016). According to (Koskela, 1992), in some instances, it appears that design wastes are higher than the cost of the design itself." Faulty designs are among the most significant risks to project delays. Buildability, structural design conflicts, poor temporary work designs, incorrect construction techniques, and information on varying site conditions are some prevalent issues resulting from design flaws (Forbes & Ahmed, 2020).

The dangers associated with their jobs, including uncertain safety, delayed payment, peer distrust, health anxiety, and excoriation, are what construction workers fear most. Delays in construction projects result in litigations, total abandonment, arbitration, dispute, cost overrun,

time overrun, changes in the scope of work on-site, delays in costing variations, and additional works (A. Singh, Kumar, Mittal, & Verma, 2023). The implications of construction delays include changed orders, interim payment, poor planning and scheduling, poor financing, and material price escalation (Forbes & Ahmed, 2020).

In the short term, there is no denying the appeal of the narrative that waste reduction will maximize productivity (Forbes & Ahmed, 2020). The long-term impact, therefore, will be to continue the downward spiral of the construction sector while enhancing its image for offering unfulfilling professions (Singh et al., 2023). Too often, efficiency in the short term is traded for long-term sustainability and competitiveness (Habibi Rad et al., 2022). Even while this enduring short-termism impedes industry growth, the technocratic elite of the sector continues to benefit from it in the near term. From a critical standpoint, an influx of "empowered" workers brimming with fresh ideas is the last thing that the present leaders in the business need (Kim and Go, 2020). Implementing a management-by-stress system where staff is continually pushed to fulfill escalating efficiency goals is far preferable—every new financial cycle ushers in a renewed focus on cost-effectiveness (Forbes & Ahmed, 2020: Singh et al., 2023).

According to (Howel, 1998), lean manufacturing practices are neutral in and of themselves. This is pretty much true in an abstract sense. Lean Construction cannot, nevertheless, be neutrally implemented in real-world settings. Every effort to change an organization disrupts the established order. Although production theories can be created outside of human capital issues, they must be applied to actual companies. An underlying human resource management policy is intrinsically linked to organizational reform activities (Forbes & Ahmed, 2020). All kinds of waste are often eliminated or reduced with the assistance lean techniques. But lean methods can't be utilized in any environment. There are some factors like a worker's experience, time, the value that's important to be considered (Kumara et al., 2022).

This section first defined the Human Capital and then examined the Human Capital concept to comprehend what it entails. Moreover, the underlying causes and origins of the Human Capital factors in the construction industry were discussed. Lastly, the significance of developing the Human Capital in Lean Construction Implementation was reviewed. Subsequently, it explores its relationship with barriers to Lean Construction Implementation. According to Table 2.12 in section 2.3.2, the link between the Human capital and barriers to Lean Construction

Implementation was illustrated. As the next step of the study, the conceptual framework stage one was developed through this detailed literature review.

2.5 Conceptual Framework – Stage 1

An analytical approach for thoroughly grasping a phenomenon is a conceptual framework. It comprises presumptions, predictions, notions, convictions, and theories that give background knowledge and justifiable data (Miles and Huberman, 1994; Robson, 2011). According to Miles and Huberman (1994), a conceptual framework is a crucial aspect of study design that could be graphically depicted or written to describe the essential concepts, variables, or elements and hypothesized links between them. The study's conceptual framework centers around Human-Capital barriers to Lean Construction Implementation. The conceptual framework Stage 1 is presented below in figure 2.2.

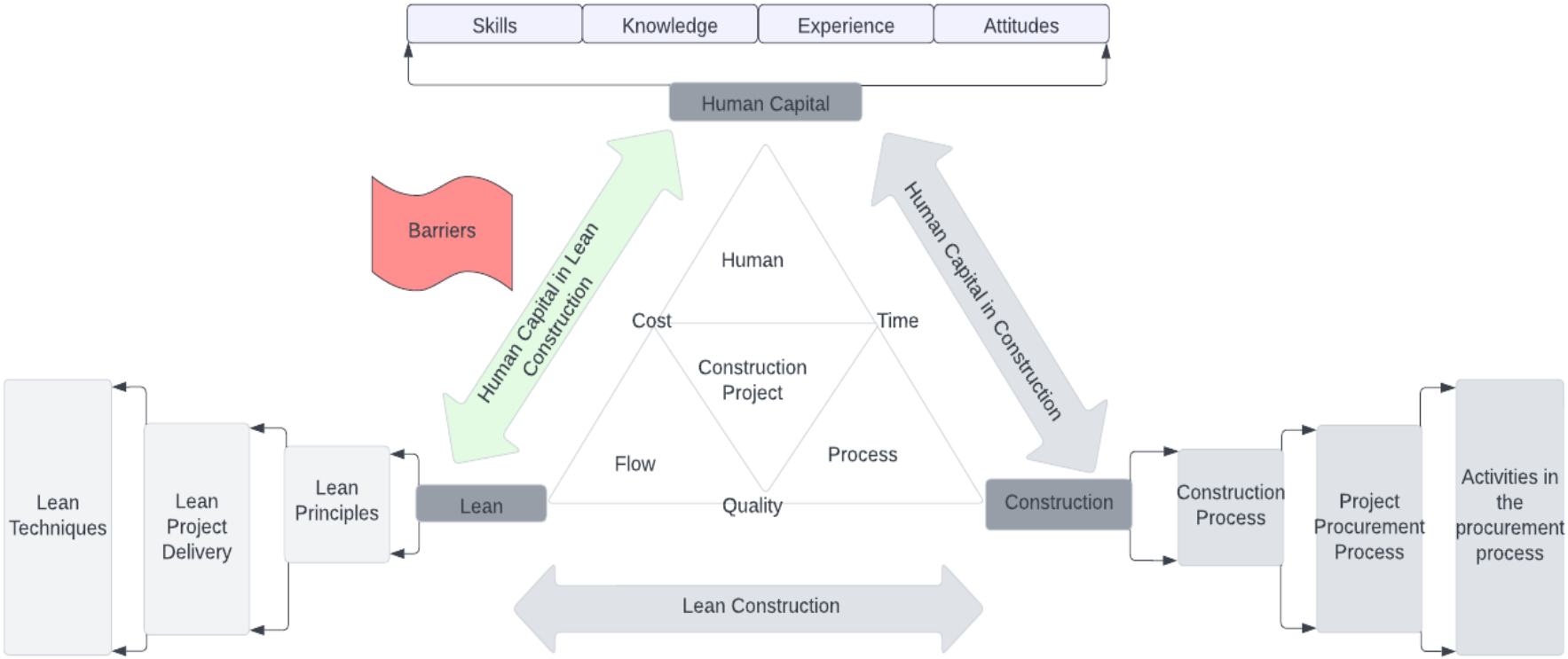

Figure 2-2 Conceptual Framework – Stage 1

Add a few sentenses

The construction industry is project centric (Koskela, 2000), and the most popular iron triangle in project management to represent Cost, Quality, and Time is in the middle of this conceptual framework. The Process is the set of construction activities within the procurement process. The Flow is the management of these construction activities, and Lean Construction is such a construction management approach. Humans need to be armed with the required skills, knowledge, experience, and attitudes which is the human capital for any successful construction project. There should be a Process, a Flow, and a Human to achieve these project deliverables. The independent variables are the human capital-related barriers to Lean Construction implementation, including cultural, leadership, structural, management, education, and human attitudinal variables.

Lean construction implementation comprises the dependent variable. This relationship is depicted in the following conceptual diagram. The problem statement of this study is that Lean Construction implementation is slow to many barriers. Therefore, it is vital to explore the barriers to Lean Construction Implementation, and the strategies to overcome these barriers are one of the objectives of this study. The figure below illustrates the developed conceptual framework – Stage 1 at the end of the detailed literature review. Stage 2 of the conceptual framework is presented in section 3.9 in Chapter 3, Systematic Literature Review.

2.6 Summary

The first objective of this research is *to identify the barriers to Lean Construction Implementation in the construction industry*. Therefore, this chapter discussed the literature on Lean Construction Implementation, its barriers, and how these barriers are related to Human Capital. Achieve objective two of this research through extant literature. First, the current construction industry was identified with different emerging innovations. Next, the nature of the construction industry was analyzed, and the non-value-adding activities in the construction activities were recognized. Subsequently, the Lean principles, lean techniques, and the lean project delivery system were discussed. Importantly, the barriers to Lean Construction Implementation were presented, and how these barriers are linked to the Human Capital area was discussed.

Next, the Human Capital in construction activities with the significance of Human capital development in Lean Construction Implementation was discussed. Finally, this chapter presents the conceptual framework in stage one. As the next step, a systematic literature review was carried out to answer the research question; *how to improve Lean Construction Implementation from Human Capital perspective?* The next chapter presents the findings from the systematic literature review with the conceptual framework stage two.

CHAPTER 3 SYSTEMATIC LITERATURE REVIEW

3.1 Introduction to the Chapter

The research question of this research is how to improve the Lean Construction Implementation from Human Capital perspective. To answer this research question, it is vital to examine what the barriers are to Lean Construction Implementation, and how they are related to the Human Capital. Moreover, it is significant to evaluate the suitable strategies to overcome these barriers. Further to the detailed literature review presented in the last Chapter, a systematic literature review was done before commencing the primary data collection to enhance the conceptual framework stage one (see section 2.5). Therefore, this Chapter presents the findings of the systematic literature review on the barriers to Lean Construction Implementation and the relationship between barriers and the Human Capital. Furthermore, this chapter discusses the suitable strategies to overcome these Human Capital barriers. The below table 3.1 illustrates the section headings and the contents of this chapter.

Table 3-1: section headings and contents

Section headings	Section content
3.1 Introduction to the chapter	Introduce the systematic literature review chapter.
3.2 Overview of the systematic literature review	Define the systematic literature review and describe the steps to conduct a systematic literature review.
3.3 Selected Literature for systematic literature review	This section presents the details of the literature selected to identify the barriers, Human Capital factors, and strategies in Lean Construction Implementation
3.4 Barriers to Lean Construction Implementation	This section presents the list of barriers identified from the selected literature.
3.5 Assessing the Human Capital Barriers in Lean Construction	This section establishes the relationship between Human Capital and the barriers to implementing Lean Construction
3.6 Most Critical Human Capital Barriers in Lean Construction	Identified Human Capital barriers are evaluated, and this section presents the most critical Human Capital barriers
3.7 Widely suggested strategies to Improve Lean Construction	This section presents the widely suggested strategies to overcome the barriers to lean construction implementation.
3.8 Developing a Lean Culture	The significance of developing a Lean Culture is discussed in this section based on the literature's findings
3.9 Conceptual framework state 2	The enhanced conceptual framework with the Lean Culture is presented and discussed here
3.10 Summary	Chapter 3 is summarized with the introduction to Chapter 4

First, an overview of the systematic literature review is presented in the below section 3.2.

3.2 Overview of systematic literature review

This review depends on a systematic literature review of published literature in Scopus and International Group for Lean Construction conference papers to identify Lean Construction Implementation barriers from 1993 to 2021. Totally 132 research papers under the title of Lean Construction Implementation were reviewed, and fifty research papers were critically evaluated to identify the barriers to lean Construction Implementation. Among this literature, ten specific studies were carried out for barriers to implementing Lean Construction. Furthermore, it is revealed that more than 60% of barriers are related to Human Capital, which is the value of the human in terms of skill, knowledge, and experience. The systematic literature review reveals that Human Capital is a significant factor in Lean Construction Implementation. Finally, the strategies to overcome these barriers were identified, and it is vital to develop a framework for Lean Construction Implementation from a Human Capital perspective.

A systematic literature review is a scientific and repeatable method for identifying, selecting, and evaluating all literature that is relevant to a particular quality level (Booth et al.,2012). The aim of the systematic literature review is to provide a clear, targeted answer to specific research questions (McCullough,2000). According to Kitchenham and Charters (2007), Systematic Literature review means identifying, evaluating, and interpreting all available research relevant to a particular topic. Overall, SLR a thorough investigation of specific research questions with a piece of sound background knowledge to identify a clear research direction for further study. Khan et al. (2003) and Li, Fang & Wu (2020) identify five steps to conducting a systematic literature review: 1) Question formulation, 2) Identifying relevant studies, 3) Assessing the Quality of studies, 4) Summarizing the evidence, and 5) Interpreting the findings. This systematic literature review on the impact of Human Capital in Lean Construction Implementation was carried out using the above five steps, and step one discusses in the next section.

Step 1: Question formulation

The problems to be addressed should be specified in the form of clear, definite and structured questions before the beginning of the systematic literature review (Khan et al., 2003). The aim of this thesis is to identify the barriers to Lean Construction Implementation and then assess the impact of Human Capital in Lean Construction Implementation. Therefore, the following four questions were formulated based objectives of the research (see section 1.3).

1. What are the barriers in Lean Construction Implementation from the Human Capital perspective? (research question 2)
2. How are these barriers for Lean Construction Implementation related to the Human Capital area? (research question 3)
3. What are the widely suggested strategies to overcome Human Capital barriers in Lean Construction Implementation? (research question 7)
4. What are the most suitable strategies to improve Lean Construction Implementation from a Human Capital perspective? (research question 8)

Step 2: Identifying relevant studies.

The first step was the formulation of the research questions to guide the review, and the next, the relevant studies were identified, followed by the literature published in Scopus and the International Group of Lean Construction to identify the articles to be included in the review. The choice of these databases was because they are reputed to be among the most significant online database of peer-reviewed articles. Scopus is a bibliographic database containing abstracts and citations for academic journal articles. It covers nearly 21,000 titles from over 5,000 publishers, of which 20,000 are peer-reviewed journals in the scientific, technical, medical, and social sciences. International Group of Lean Construction Founded in 1993, the International Group of Lean Construction (www.iglc.net) is an international network of researchers from practice and academia in Architecture, Engineering, and Construction who feel that the practice, education, and research of the Architecture, Engineering, and Construction industry must be radically renewed in order to respond to the global challenges ahead.

Step 3: Assessing the quality of studies.

This step is to identify the inclusions and exclusions. In carrying out the searches for the article in Scopus, "Lean Construction Implementation" was used to identify the articles with Lean Construction Implementation in their titles. Lean Construction emerged in 1993, and this search was done irrespective of the time frame. From the search, It was found the articles in the form of research papers. Totally, ninety-two research papers were found, and twenty eight were selected, screening them with the criteria of only journal articles, leaving the conference papers out because the quality of the Journal articles is more valid and reputed. International Group of Lean Construction publications started in 1993, and fifty literatures were found up to 2021. After reading the abstract, twenty-two articles were selected after screening and sorting them, considering the articles which are specifically focused, on Lean Construction

Implementation. This review focuses on the issues and barriers in Lean Construction Implementation rather than Lean techniques and their benefits to answer the research questions of this thesis.

Step 4: Summarizing the evidence.

The **s**elected articles were read by the authors with the aim of identifying the barriers to Lean Construction Implementation. The review of all articles and analysis of their contents resulted in the generation of both quantitative and qualitative data. First, the data were analyzed using frequencies, percentages, and ranking, while the latter was analyzed using thematic content analysis. The results were presented using tables, charts, and texts for easy understanding and drawing of conclusions.

Step 5: Interpreting the findings.

This section discusses findings based on the results based on the three research questions guided by this systematic literature review. The findings are compared with the existing knowledge, and at the end, the way forward and future direction is presented, identifying the way forward of this research. The identified barriers in Lean Construction Implementation were first listed into ten categories, nine specific studies, and then a common category for all other 35 studies. The barriers in Lean Construction Implementation of each category were evaluated to classify Human Capital as related or not related. These data were presented as percentages as well as in numbers. It was revealed that more than 45% of barriers are related to Human Capital. Secondly, the thematic content analysis explored the common Human Capital factors associated with barriers in Lean Construction Implementation. There were nine Human Capital-related factors, and these factors will be further examined to identify the strategies to overcome the Human Capital related barriers in Lean Construction Implementation as the way forward of this thesis. Next, the selected literature for this systematic literature system are presented.

3.3 Selected literature for systematic literature review

According to the selected sources of the literature, there is literature from 1993. However, the first literature selected for this thesis is from 1999, considering the exclusions and inclusions identified for this systematic literature review. Altogether there are fifty studies selected up to 2021 and Figure 3.1 below illustrates the distribution of these studies throughout this time frame.

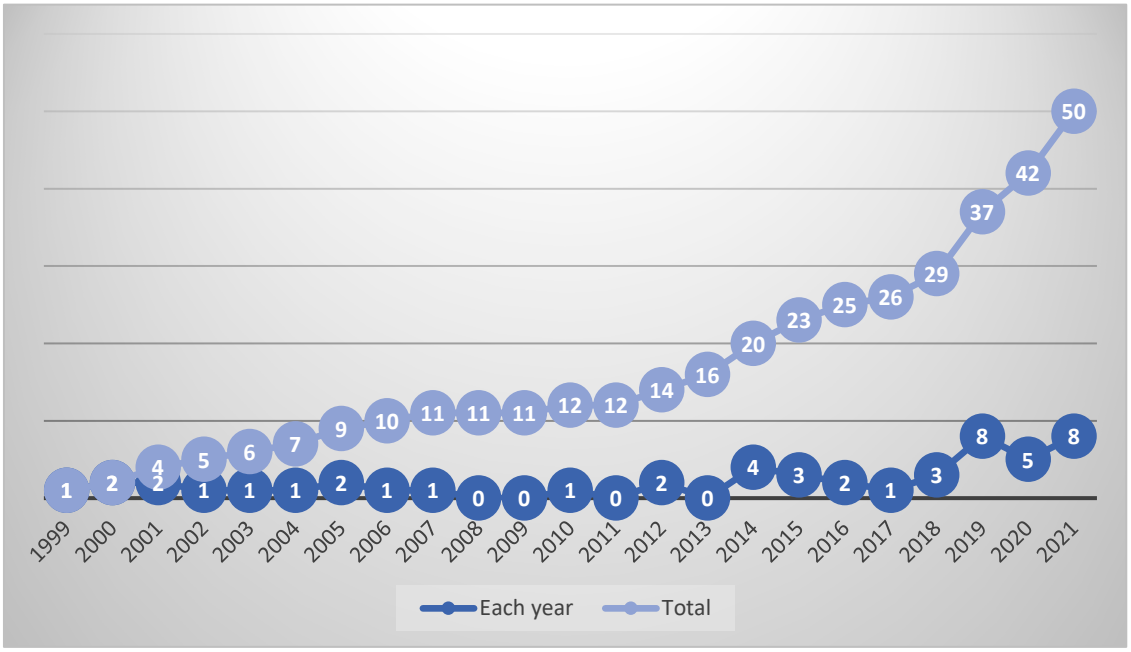

Figure 3-1 Chronology of selected fifty literature on Lean Construction Implementation

According to the above graph, there have been more studies in the last recent years from 2014. However, there was a lack of studies in 2017 and in 2008 and 2009. In 2019 and 2021, the highest studies were reported as eight each year, out of fifty studies selected for this systematic literature review. Among these studies, ten specific studies were carried out to identify the barriers in Lean Construction Implementation, and table 3.2 below demonstrates the details of those ten studies.

Table 3-2 Specific ten literature on barriers in Lean Construction Implementation

Literature 1	Mano, A. P., Gouvea da Costa, S. E., & Pinheiro de Lima, E. (2021). Criticality assessment of the barriers to Lean Construction. International Journal of Productivity & Performance Management, 70(1),
Literature 2	Enshassi, A., Saleh, N., & Mohamed, S. (2021). Barriers to the application of lean construction techniques concerning safety improvement in construction projects. International Journal of Construction Management, 21(10), 1044-1060
Literature 3	Albalkhy, W., & Sweis, R. (2021). Barriers to adopting lean construction in the construction industry: a literature review. International Journal of Lean Six Sigma, 12(2), 210-236
Literature 4	Shakil, A., & Md Habibur Rahman, S. (2019). Challenges of implementing lean construction in the construction industry in Bangladesh. Smart and Sustainable Built Environment
Literature 5	Demirkesen, N. Wachter, S. Oprach and S. Haghsheno(2019) Identifying Barriers in Lean Implementation in the Construction Industry
Literature 6	Mohamed Saad Bajjou and a. Anas Chafi (2018) Lean construction implementation in the Moroccan construction industry: Awareness, benefits, and barriers

Literature 7	S. a. B. Khaba, C. (2017) Modelling the key barriers to lean construction using interpretive structural modelling
Literature 8	S. Cano, J. Delgado, L. Botero and O. Rubiano (2015) Barriers and Success Factors in Lean Construction Implementation
Literature 9	G. Shang, and Sui Pheng, L. (2014) Barriers to lean implementation in the construction industry in China
Literature 10	L. F. Alarcón, S. Diethelm, O. Rojo and R. Calderon (2005) Assessing the Impacts of Implementing Lean Construction

This systematic literature review is based on fifty literature, and ten specific studies carried out for barriers in Lean Construction Implementation are presented above. The authors of the other forty literature are presented in the table 3.3 to acknowledge the authors.

Table 3-3 The authors of the other forty literature selected for the systematic literature review

Year of publication	**Names of authors**
2021	Hamzeh, F., González, V. A., Alarcon, L. F., & Khalife, S.; Jacobsen, Emil L. Strange, Nikolaj S. Teizer, Jochen; Srinivas,; K Trentin, Bianca T. Etges, Bernardo M. B. S.
2020	R. Walter, M. Weinmann, C. Baier, S. Oprach and S. Haghsheno; S. Li, Y. Fang and X. Wu: S. Demirkesen and H. G. Bayhan; S. Cano, L. Botero, J. L. García-Alcaraz, R. Tovar and L. Rivera
2019	X. Wu, S. Li, H. Yuan, G. Wang and G. Wu, A. Wallace, M. Marcelo and T. Guilherme Luiz, J. von Heyl and S.-T. Demir, S. Sarhan, C. Pasquire, A. Elnokaly and S. Pretlove, M. Poshdar, V. A. Gonzalez, R. Antunes, N. Ghodrati, M. Katebi, S. Valasiuk, H. Alqudah and S. Talebi, S. Jamil Ghazi, X. Bo, F. Sabrina, K. Azharul, O. Ayokunle Olubunmi and C. Vaughan, C. Ghannoum, S. Antar, Y. Daoud and F. Hamzeh, E. Adnan, S. Nour and M. Sherif
2018-2015	O. Torp, J. B. Knudsen and I. Rønneberg, a. Jamil Sarhan, a. Bo Xia, a. Sabrina Fawzia, a. Azharul Karim and a. Ayokunle Olanipekun; J. L. Salvatierra, R. Funk and L. F. Alarcón, T. d. C. L. Alves, M. M. Azambuja and B. Arnous; A. Mossman, P. J. Ebbs, P. Sexton, D. G. Greensmith, B. G. Clare, V. Gibson and R. Turner, D. G. Greensmith, B. G. Clare, V. Gibson, and R. Turner
2014-2006	S. Wandahl, F. Emuze and H. Ungerer, L. E. Bygballe and A. Swärd, B. Andersen, A. M. Belay and E. A. Seim, R. Al-Aomar, B. Chesworth, K. London and T. Gajendran, J. d. P. B. Neto and T. d. C. L. Alves, I. Pavez and L. F. Alarcón
2005-1999	Orr, Cameron, B. Jorgensen, S. Emmitt and S. Bonke, J. C. Almeida and G. F. Salazar, L. F. Alarcón and L. Seguel, D. Seymour and J. Rooke, M. F. Dulaimi and C. Tanamas, S. D. Green, M. Coffey, S. D. Green

Below figure 3.2 illustrates the number of each year of literature selected for this systematic review. For example, there are ten literature 2005 to 1999.

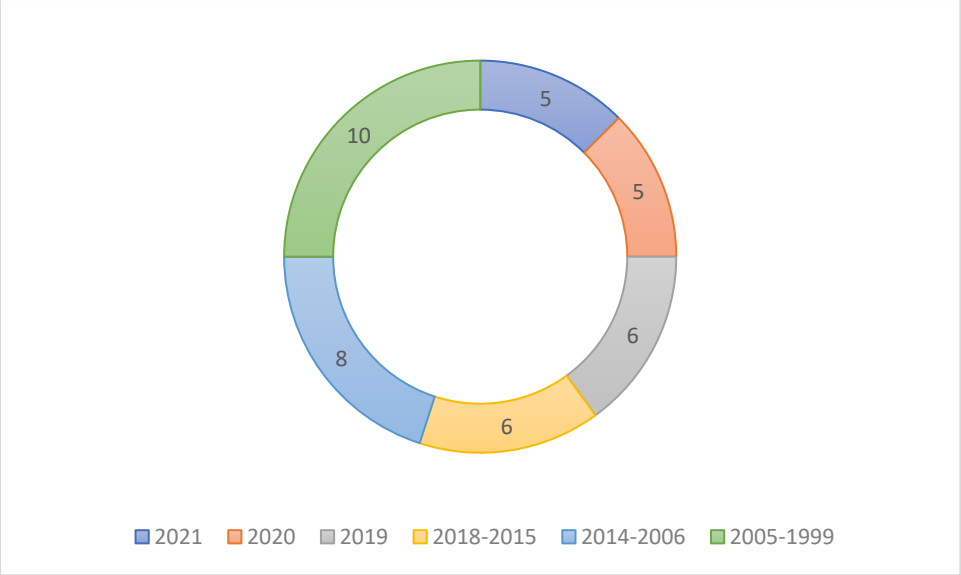

Figure 3-2 Literature on Lean Construction Implementation

Next, the discussions based on the results are presented as the answers to the questions formulated for this systematic literature review.

3.4 Barriers in Lean Construction Implementation from Human Capital perspective?

The first question arose to identify the barriers identified in the fifty selected literature. These fifty literatures were divided into two categories, first, the specific ten literature on barriers in Lean Construction Implementation, secondly, other forty literature on Lean Construction implementation reviewed for any barriers identified. First it is discussed the ten specific literature findings on barriers to Lean Construction Implementation. Furthermore, this graph illustrates the number of barriers identified within each study. For example, Shakil and Md Habibur Rahman (2019) have identified 41 barriers, whereas Alarcón et al. (2005) have identified eight barriers, and the other studies are presented in the below figure 3.2.

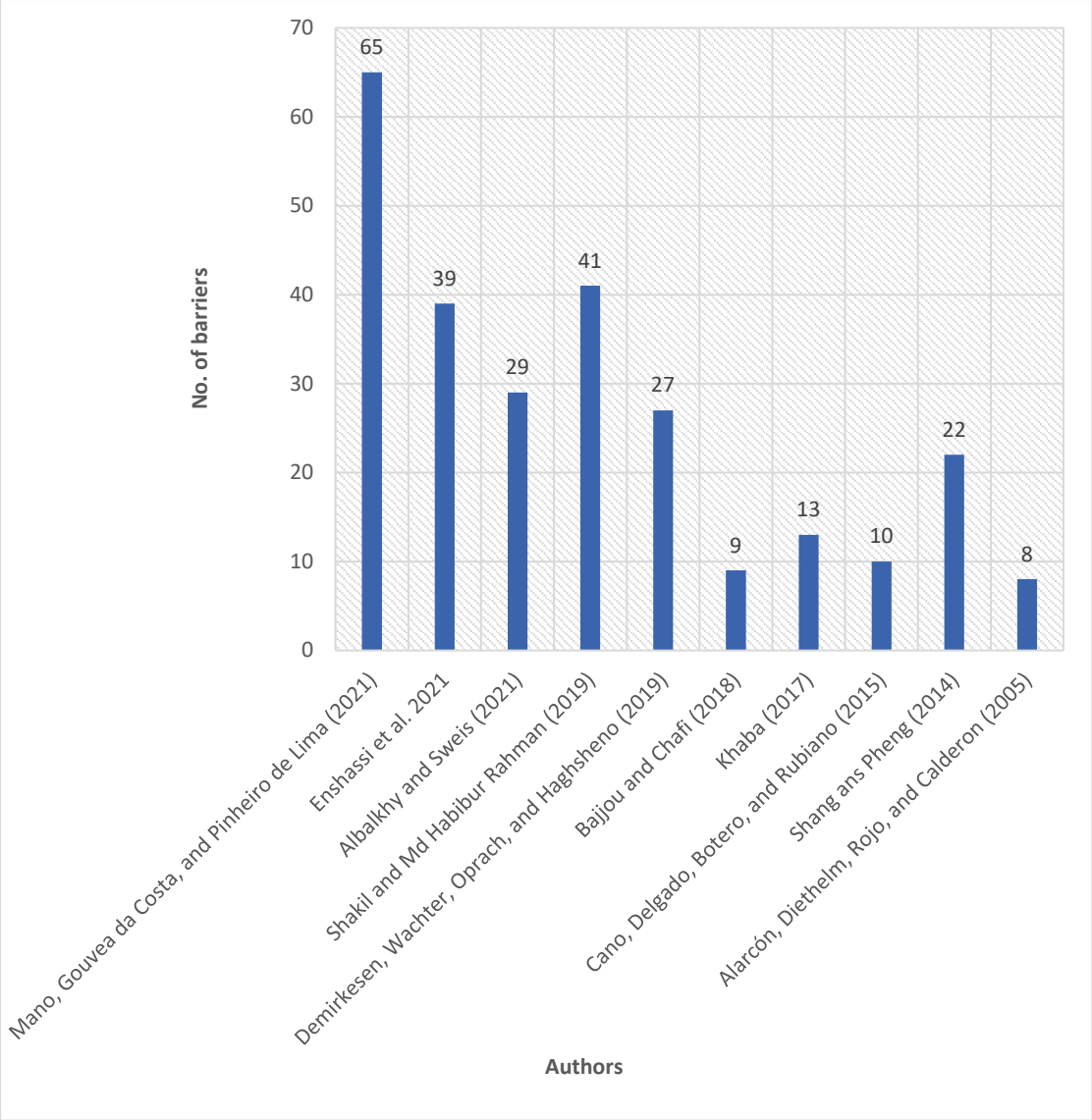

Figure 3-3 Number of barriers identified through the systematic literature review.

The below table 3.4 summarizes the barriers on Lean Construction Implementation.

Table 3-4 Evaluation of barriers to lean Construction Implementation

Literature	Barriers to Lean Construction Implementation	Evaluation of barriers to lean Construction Implementation
(Mano et al., 2021)	The purpose of *this study* sought to identify the critical barriers to the deployment of Lean Construction. The research methodology was a systematic literature review. *This thesis* identified 83 potential pre-deployment barriers in the literature. Among these barriers, 65 are internal barriers related to Cultural-24, Political-18, Strucutural-18, and Leadership-5 whereas 18 are related to competitive-4, economic-5, political-3, social-4 and technological environment-2.	The Most critical barriers are thus subcategorized: Cultural-related barriers include lack of commitment to the team, difficulty in focusing the business on the customer, resistance to change from the fear of unknown practices, and seeing the new with scepticism and pessimism. Leadership Barriers are difficulty getting support and commitment from top management, resistance to change by the leadership, centralization of decisions and the challenge of establishing participatory management, and insufficient knowledge of managers to manage the change process. Structural aspects Barriers are the inability to measure project progress
(Enshassi et al., 2021)	A total of 39 barriers were identified through an intensive literature review. Furthermore, these barriers were categorized into six categories; management, financial, educational, governmental, technical, and human attitudinal. Cultural aspects Barrierr are barriers are Lack of commitment to the team, difficulty in focusing the business on the customer, resistance to change arising from the fear of unknown practices and seeing the new with skepticism and pessimism.	Leadership Barriers are difficulty getting support and commitment from top management, Resistance to change by the leadership, centralization of decisions and difficulty in establishing participatory management. Insufficient knowledge of managers to manage the change process. Structural aspects Barriers are the inability to measure project progress
(Albalkhy & Sweis, 2021)	The purpose of this paper is to identify and theoretically explain the general barriers to adopting lean construction practices in the construction industry regardless of the country or the company size, or specialization, and to suggest future research studies in this field	Twenty-nine barriers were identified and explained, and a proposed model to classify the sources of the barriers was chosen. Seventeen barriers were classified as internal environment-related barriers, five were labour-related, three were materials-related and four were exogenous barriers. In addition, some directions for the future research studies were suggested.
(Shakil & Md Habibur Rahman, 2019)	The purpose of this study was to identify the challenges of Lean Construction Implementation in the Bangladeshi construction industry. A structured questionnaire survey was used to collect the data from Bangladeshi construction practitioners. The findings revealed 41 barriers in Lean Construction Implementation, and the highest-ranking challenges are the lack of awareness about lean construction, lack of skills, training, and lean techniques,	The findings revealed 41 barriers in Lean Construction Implementation, and the highest-ranking challenges are the lack of awareness about lean construction, lack of skills, training and lean techniques, unwillingness to change the existing culture, lack of management commitment, and fragmented and cyclic nature of the construction project and unavailing communication between all project participants.

	unwillingness to change the existing culture, lack of management commitment, fragmented and cyclic nature of the construction project and unavailing communication between all project participants.	
(Demirkesen, Wachter, Oprach, & Haghsheno, 2019)	The purpose of this was to identify and categorize barriers leading to poor implementation of the Lean Philosophy. Totally 27 barriers have been identified using a questionnaire survey administered to lean Construction professionals. The highest-ranking barriers were lack of 'top management support,' 'misperception about Lean practices', and 'lack of information sharing and integrated change control. Within this study, the barriers to Lean Construction Implementation were identified into different groups such as political, economic, technical, workforce, cultural, managerial, and communication. Results indicated that the most important barriers could be found in the socio-cultural background. The top three listed barriers are: 'Lack of top management support, 'misperception about Lean practices,' 'lack of information sharing and integrated change control.'	In all, 27 barriers have been identified using a questionnaire survey administered to lean Construction professionals. The highest-ranking barriers were lack of 'top management support,' 'misperception about Lean practices', and 'lack of information sharing and integrated change control. Within this study, the barriers to Lean Construction Implementation were identified into different groups such as political, economic, technical, workforce, cultural, managerial and communication. Results indicated that the socio-cultural background could be the most important barrier. The top three listed barriers are: 'Lack of top management support,' 'misperception about Lean practices,' and 'lack of information sharing and integrated change control.'
(Mohamed Saad Bajjou & Anas Chafi, 2018)	The purpose of this study was to explore the current level of awareness of Lean Construction practices among Moroccan construction professionals to assess the potential benefits derived from Lean Construction practices. Furthermore, this study aimed to identify the critical barriers hindering a successful Lean Construction Implementation The research methodology was a quantitative approach using a structured questionnaire survey. The findings revealed that 61% of the respondents are familiar with Lean Construction n practices, and there are nine potential barriers in Morrocco.	These nine barriers were prioritized based on the responses, and the table below illustrates these nine barriers to Lean Construction Implementation with the priority. The most critical barrier is a Lack of knowledge about Lean Construction practices, and the second highest is Unskilled Human Resources so on and so forth. Moreover, this study concludes that the main barriers hindering a successful lean construction deployment in Morocco are a lack of knowledge about lean philosophy, unskilled human resources and insufficient financial resources.
(Khaba, 2017)	The purpose of this study was to identify and analyze the key barriers to lean implementation in the construction industry. The research methodologies were Literature review and expert opinions. First, 13 barriers to Lean Construction were identified through an extensive review of the literature and subsequently eliciting expert opinions. The table below shows the 13 barriers identified for the study.	The findings revealed that cultural differences are the most important barrier to Lean Construction, whereas the employee's resistance to change and lack of performance measurement systems are the least significant barriers. The findings revealed that cultural differences are the most important barrier to Lean Construction, whereas the employees' resistance to change and

		lack of performance measurement systems are the least significant barriers. The most critical barriers include difficulty having appropriate people for Lean Construction's application and lack of identification and control of waste.
(Cano et al., 2015)	This study was done to identify the barriers and critical success factors involved in the Lean Construction Implementation. Eighty-three academic articles published between 1998 to 2014 were examined to identify 110 barriers under six groups: people, organizational structure, supply chain, external value chain, internal value chain, and externalities.	The barriers identified through the detailed literature review were further categorized into 20 sub-categories, and then critically analyzed the survey results to identify the most critical barrier: Difficulty in having appropriate people for Lean Construction 's application. 2. Lack of identification and control of waste. 3. The results are not fast and often only partially visible. 4. Poverty and social problems. 5. The own informality of local industry. 6. Lack of self-esteem and initiative on the part of individuals.
(Shang, 2014)	This study aimed to build on previous research into lean practices and the associated barriers reported in various contexts that hinder the implementation of lean practices in the construction industry. A large-scale of Chinese building professionals are used to identify these barriers. The below table shows 22 barriers identified through the study.	The findings revealed that the most crucial barriers to the implementation of lean practices include 'their lack of long-term philosophy, "the absence of a Lean Culture in their organization", the use of multi-layer subcontracting". Furthermore, this study concluded that six underlying factors hinder implementation lean practices in the Chinese construction industry. These issues are; people and partners, managerial and organizational, lack of support, culture and philosophy, government, and procurement.
(Alarcón et al., 2005)	This study aimed to analyze the evidence obtained from the implementation of Lean Construction practices in the construction industry. Furthermore, this study discussed the difficulties and barriers to Lean Construction Implementation, and the following barriers were identified. The findings revealed that the key barriers are lack of training, lack of organizational elements to respond to Lean Construction Implementation, Lack of self-criticism, which limits the capacity to learn from errors, lack of time for implementing new practices, Low understanding of the concepts, inadequate administration, weak communication, and lack of integration.	The findings revealed that the key barriers are lack of training, lack of organizational elements to respond to Lean Construction Implementation, lack of self-criticism, which limits the capacity to learn from errors, lack of time for implementing new practices, Low understanding of the concepts, inadequate administration, ineffective communication, and lack of integration.

This systematic literature review is based on fifty literature and ten is specifically for barriers to Lean Construction Implementation, and the rest of forty literature are on Lean Construction Implementation. In the above section, these specific ten studies were presented, and the details of other literature selected for this study are presented in the next section.

Barriers to Lean Construction Implementation emerged from the other forty studies.

There are forty publications selected for this study with the keywords of "Lean Construction," and these were thoroughly evaluated to identify the barriers to Lean Construction Implementation. First, the abstract and the conclusion were read, and then the results and discussions were critically evaluated to identify the barriers to Lean Construction Implementation. The following barriers indicated in table 3-5 were identified within these forty number of previous studies on Lean Construction Implementation. The names of authors of these forty studies are as per the table 3-3 above.

Table 3-5 Barriers identified through the forty literature with the title of Lean Construction

Social factors for cultural change are neglected	Changing organizational culture and mindsets is difficult
Environmental factors: pressure from govt market, media, public, supply chain	Practitioners are focused on "wins" and "proof" rather than the management philosophy that is Lean Construction
Organizational factors: Risk control, resource readiness, enterprise information, supervisor support Lean Culture, regulations to facilitate the adoption of Lean Construction, Lean Construction training	The most common barrier seems to relate to issues around insufficient knowledge. The cultural issue is also an often-mentioned barrier.
Lack of training,	Projects are very autonomous
Lack of motivation employees	Language and cultural barriers prevent creating awareness of lean thinking issues such as training, language barriers, and cultural aspects.
Lack of proper problem-solving practices	Resistance to change Self-criticism Short-term vision
The traditional wasteful approach	Construction professionals do not perceive the lean construction.
Lack of understanding about lean thinking concepts and their implementation in construction from an organization perspective and cultural barriers	Conflicts were nourished by unpredictability and the absence of interest and responsibility concerning the total project performance.
Resistance to change.	Focus on short-term goals.
In-group collectivism	Project participants showed reluctance to share information and plan.
Cultural interpretations constituted a considerable impediment to process-orientated	One-of-a-kind products: the lack of repetitive cycles for feedback within a specific project and

cooperation in an otherwise traditional project organization.	restricted means for comparison with finished products.
There was not any forum for discussion of lean across the divisions. No common arena for exchanging valuable experience and learnings from their improved work	Site productions relate to uncertainty with weather, local labour and materials, problems with the coordination of crews around the production site,
No common arena for exchanging valuable experience and learnings from their improved work	Different meanings are given to Lean, its tools, and its principles.
No Human resources management practices	Regulatory Authorities: construction projects are subject to approval from authorities,
Temporary Multi-organization: poor communication among participating organizations, lack of stimulus for long-term improvement, liability issues, and inability to accumulate knowledge.	Worry about the dehumanizing side effects. The employees are exhausted. Unfriendly personnel practices possess an institutionalized regressive Lean Culture, despite notable exceptions.

In this section, the barriers identified through fifty studies were presented. It is evident there are lists of barriers to Lean Construction Implementation, which were identified by the different authors from 1999 to 2021. Next, question 2 of the systematic literature review: *how these barriers are related to the Human Capital area, i*s discussed.

3.5 Assessing the Human Capital in Lean Construction Implementation?

As the next step of the systematic literature review, the identified barriers were evaluated to identify how Human Capital factors are associated with the barriers in Lean Construction Implementation using thematic analysis. All barriers were critically read by their meaning to identify whether the barrier is a Human Capital related barrier or non-related to the Human Capital factors. For example, "resistance to change" is a Human Capital related barrier, whereas "lack of government support" is not a Human Capital related barrier. Taking this into consideration, every barrier was identified as Human Capital related and Human Capital not related. The results of each set of barriers are presented below. First, the barriers identified through ten specific studies are evaluated. The evidence of Human Capital area is highlighted in bold, have counted them to see the percentage to the total number of barriers. It is revealed that more than half of the barriers are Human capital-related barriers. The below table 3.6 to 3.15 illustrate the barriers to Lean Construction Implementation by highlighting the Human Capital in bold in ten specific literatures selected for this systematic literature review.

Table 3-6 Evidence for Human Capital barriers (Mano et al., 2021)

Lack of commitment to the team	The difficulty of the company in abandoning **old habits**
Difficulty in focusing the business on the customer	There is no conceptual phase in the project where all stakeholders participate, from those who will define the project to those who will execute it
Resistance to change arising from the fear of unknown practices, seeing the new with skepticism and pessimism	High turnover of operational staff (**lack of stability of workers** at the operational level)
Companies focus on product transformation without considering process flow	Interruption of production/construction by changes made in the project
Lack of knowledge, understanding and awareness of the new management system (be it Lean, Last Planner, Quality.	Existence of distorted norms, privileges, taboos and information **hampering the learning process**
Lack of ability to work in teams	Definition of the quantity and **qualification of workers** performed by persons external to the process
Lack of time to invest in process improvement	Variability in the final product in relation to the values specified in the project
Limited vision about Lean: isolated application of process improvement tools	Defensive organizational models in terms of qualified incompetence
Decisions are solely based on the project's cost without the indirect costs involved (hidden wastes), which interfere with creating value.	Inflexibility to review budgets agreed in the contract
Inexistence of group culture	Low implementation of new technologies available
View the hours spent in planning the new system, or even the daily **meetings, as a waste.**	**Individualistic behaviour** of the project area
Cultural aspects of the building industry such as opportunistic, change-resistant, conflict-prone	Existence of power sources that **limit the flow of information between teams** and reduce transparency or even from interpersonal relationships used to influence the project in favour of someone
Need for short-term results (due to the temporary factor that involves work)	Low professional remuneration
Lack of a long-term supplier relationship policy	Inability to measure project progress
Selection of suppliers based primarily on the lowest cost policy	Performance strategy that is inadequate or non-existent
Company history of abandoning complex tools before the result of using them becomes evident.	Lack of procedures, norms and standards for carrying out activities
Difficulty in achieving consensus within teams	Poor and inadequate planning, often without the existence of long-term planning
Do not involve customers or limit their participation in the process as a whole.	Inability to measure **team performance**

Past unsuccessful experiences with the implementation of some system/management tool	Undefined requirements for quality control
Lack of previous experience with Lean	Lack of methods to ensure product quality
Difficulty or slowness in learning from mistakes	Processes that **depend on "key people."**
Inefficient use of available quality standards (e.g., the family of ISO 9000 standards)	Lack of clear procedures to manage project uncertainties plus the difficulty of establishing the lungs where they really are needed
Lack of incentives and reward programs	Definition of planning the project schedule without the involvement of who will execute it
Difficulty getting support and commitment from top management	Difficulty working on defect prevention
Resistance to change by the leadership	Difficulty investing extra funds to provide training for their workers beyond what is required by law
Centralization of decisions and difficulty in establishing participatory management	Delay in delivery of materials
Insufficient knowledge of managers to manage the change process	Quality with a focus on inspection
Delays in decision-making involving managers	The project structure is characterized by its temporary character, high division of labour and many hierarchical layers
The difficulty of interaction/collaboration between the different companies that work on the same project	Financial difficulty in providing resources when necessary
Low level of integration between designers and the area of execution of the project	Reduced investment in the necessary equipment
Competition between the various departments of the company (acting as if they were different companies)	A high number of **outsourced workers**
Company practice **in seeking guilty in the face of an error**	The difficulty of the company in abandoning **old habits**
Inaccurate and incomplete drawings make project execution difficult.	

As per the above evaluation, it is revealed that out of 65 barriers, 33 barriers (in italic highlighted) are related to the Human Capital area. As a percentage, it is 51%. Similarly, the evaluation done critically for the next study is presented in below tables 3.9 to 3.17, and the summary is at the end of this section.

Table 3-7 Evidence for Human Capital Barriers (Enshassi et al., 2021)

Lack of management support and commitment to the application of Lean Construction techniques in safety improvement	**Lack of awareness program** to increase knowledge about Lean Construction

Poor project definition, which explains the vision, mission, and main objectives of the project and its stakeholders	**Lack of information and experience** sharing among construction firms
Centralization of decision making	Lack of government support towards the construction projects to apply any innovative strategy
Lengthy approval procedure from top management to take any step	Inconsistency in the government policies
Lack of time in construction firms for innovation and application of any innovative strategy	Government bureaucracy and instability
Lack of transparency	Unsteady price of commodities (e.g. PPE, safety signs, and many more)
Poor communication among project parties (managers, administrators, foremen, and many more)	Lack of agreed implementation methodology to implement Lean Construction techniques
Poor coordination among project parties (managers, administrators, foremen, and many more)	The complexity of Lean Construction Implementation since Lean Construction does involve not only applying Lean Construction techniques on site but also developing a culture among the staff for continuous improvement.
Absence of long-term forecast for safety improvement	A long implementation period is needed for Lean Construction techniques application in safety improvement
Inadequate planning to apply Lean Construction techniques in safety improvement	Incomplete designs lead to an increase in the probability of re-work
Logistics problems (e.g., **poor management** of materials, equipment and tools and short supply of materials)	Poor performance measurement strategies
Inadequate funding for the project to provide the required resources and training	Fragmented nature of the construction industry
Low tender prices	**Selfishness among professionals** to provide their experience in using Lean Construction techniques to improve safety
High cost of Lean Construction Implementation, including the cost of training, consultancy fees and cost of conducting workshops	**Lack of teamwork**
Poor salaries do not encourage **employees to apply any innovative strategies.**	**Poor leadership**
Lack of incentives and motivation	**Cultural issues**
Lack of Lean Construction **concept understanding**	**Resistance to change by employees**
Lack of knowledge to apply Lean Construction techniques in safety improvement	**Lack of self-criticism,** which limited the capacity to learn from errors

Lack of technical skills to apply Lean Construction techniques in safety improvement	**Fear of unfamiliar practices** due to the misconceptions and misunderstandings of Lean Construction
Lack of education and training needed to apply Lean Construction techniques in safety improvement	

As per the above evaluation, it is revealed that out of 39 barriers, 19 barriers are related to the Human Capital area. As a percentage, it is 49%.

Table 3-8 Evidence for Human Capital Barriers (Albalkhy & Sweis, 2021)

Poor understanding of the customer needs and lack of customer focus	Hierarchies in organizational structures/ unsuitable organizational structure
Management **resistance to change**	Centralization of the decision and a**voiding making decisions, and taking responsibility** from those who are not in the top management
Lack of support and commitment from top management	**Lack of identification** and control of waste
Lack of involvement and transparency among stakeholders	Employees' **resistance to change and fear** of unfamiliar practices
Lack of adequate lean **awareness** and **understanding**	**Unskilled labour and the low level of education** of the site foreman
The results are not fast and often only partially visible, and may not conform to high expectations from management.	Insufficient **training for workers**
Lean may lead to additional cost/ implementation cost	Labour considers lean too complex High turnover of the workforce
I**naccurate and incomplete designs** and a lack of applying the concept of design constructability	Inadequate delivery performance and delays in materials delivery
The **reluctance of project participants** to share risks	Lack of long-term relationships with suppliers
Lack of a **long-term philosophy** and planning	Limited use of off-site construction techniques and the lack of prefabrication
Lack of planning for quality	Due to the fragmented nature of the construction industry, / so many parties joined the project, especially subcontractors and suppliers
Poor leadership and insufficient management skills	Lack of integrated procurements
Lack of incentives and motivation and poor professional wages	Stringent requirements and approvals during contracting
Inadequate administration of the necessary information to generate a learning cycle and take corrective actions	Lack of support from the government

As per the above evaluation, it is revealed that out of 29 barriers, 15 barriers are related to the Human Capital area. As a percentage, it is 52%.

Table 3-9 Evidence for Human Capital Barriers (Shakil and Rahman 2019)

Slow decision-making process from executive	**Shortage of human resources**
Human attitude issues in the organization	**Unclear** project definition and job specification
Inadequate pre-planning	**Inefficient** resource **management**
Lack of management **commitment**	End-user preference
Lack of standardization	Lack of strategic and long-term supplier relationship
Time and commercial **pressure**	Uncertainty (delay and shortage) in the supply chain process
Lack of clear definition of **individual's responsibility**	**Lack of skills, training** and lean techniques
Unavailing communication between all project participants	Extensive use of sub-contractors
Lack of teamwork	Fragmented and cyclic nature of the construction project
Lack of government support	The long implementation period of lean principles
Low tender prices	Lack of durable performance measurement system
Lack of understanding of customer needs and requirements	Deficiency in advanced **technical knowledge and skills**
Unfriendly organizational culture	Lack of customer satisfaction measurement system
Less involvement of contractors and specialists in the design process	**Use of non-standard** components
Lack of client and supplier involvement	Insufficient financial resources
Additional cost and high inflation rates	**Lack of awareness** about lean construction
Uncertainty in the production process	**The hegemony** of the traditional management practice
Lack of individuals performance measurement, **reward system and motivation**	**Incomplete complicated** design
Traditional design approach	Lack of agreed implementation methodology
Unwillingness to change the existing culture	**Ineffective** waste **management**
Lack of technological **adaptations**	

As per the above evaluation it is revealed that out of 41 barriers, 21 barriers are related to the Human Capital area. As a percentage, it is 51%.

Table 3-10: Evidence for Human Capital Barriers (Demirkesen et al., 2019)

Lack of top management **support**	Market conditions
Misperceptions about Lean practices	**Stress and pressure** in deadlines
Lack of information sharing and integrated change control	The complexity of Lean philosophy and terms
Inefficiency in resource planning	**Risk aversion** in Lean implementation
Failure in operational excellence	Complexity in design
Stakeholder **issues in communication**	Inefficiency in Takt time planning

Lack of **organizational communication**	Stringent requirements and approvals
Employees' **Resistance to Lean**	Dimensional variation cost of Lean tools
Resistance to change	**Lack of knowledge** in Last Planner implementation
Problems in teamwork and diverging aims in Lean	**Insistence** on mass production
Diversity in adopting Lean Culture	Consulting costs in Lean
Lack of knowledge in Lean	**Language problems for non-native speakers**
Inventory costs	Lack of government support for research and collaboration in Lean
Lack of **long-term Lean philosophy**	

As per the above evaluation it is revealed that out of 27 barriers, 15 barriers are related to the Human Capital area. As a percentage it is 55%.

Table 3-11: Evidence for Human Capital Barriers (Mohamed Saad Bajjou & Anas Chafi, 2018)

Unskilled Human Resources	**Cultural and human attitudinal issues**
Insufficient financial resources	Time and commercial **pressure**
Lack of commitment from top management	Fragmentation and subcontracting
Resistance to change	

As per the above evaluation, it is revealed that out of 9 barriers, five barriers are related to the Human Capital area. As a percentage it is 55%.

Table 3-12: Human Capital Barriers (Khaba, 2017)

Lack of **technical capabilities**	Project subcontracting
Resistance to change	Financial Constraints
Lack of green **initiatives**	**Lack of understanding** of customer needs
Not recognizing the financial advantage.	Lack of planning for quality
Lack of performance measurement systems	**Lack of lean consultants and trainers**
Inconsistency in the Government support	**Cultural differences**
Lack of awareness and understanding of lean construction	

As per the above evaluation it is revealed that out of 13 barriers, seven barriers are related to the Human Capital area. As a percentage it is 54%.

Table 3-13: Evidence for Human Capital Barriers (Cano et al., 2015)

Cultural problems	**Resistance to change** by workers

Lack of **participation and integration** of all stakeholders	Lean Construction **insufficient training**;
Lack of knowledge, understanding and awareness of Lean	poor and inadequate planning
Resistance to change by managers	Lack of **proper attitude**
Dichotomy design - construction;	Lack of **commitment** to continuous work.

As per the above evaluation it is revealed that out of 10 barriers, 8 barriers are related to the Human Capital area. As a percentage it is 80%.

Table 3-14: Evidence for Human Capital Barriers (Shang, 2014)

Lack of a ***long-term philosophy***	Employee ***resistance to change***
Absence of a Lean Culture in the organization	Management ***resistance to change***
Limited use of design-and-build procurement mode	***Employee tolerance*** of untidy workplaces
Construction firm's limited involvement in the design	***Absence of a Lean Culture*** in the partners
Insufficient knowledge of lean	Inadequate delivery performance
Multi-layer subcontracting	Hierarchies in organizational structures B18: Less personal empowerment
Limited use of off-site construction techniques	Ranking of hindrances to implementing lean practices in China
Insufficient management skills	Avoid making decisions and ***taking responsibility***
Lack of support from top management	Using guanxi or ***relationships to conceal mistakes***
High turnover in the workforce	Stringent requirements and approvals
Insufficient training	Lack of support from the government

As per the above evaluation it is revealed that out of 22 barriers, 11 barriers are related to the Human Capital area. As a percentage, it is 50%.

Table 3-15: Evidence for Human Capital Barriers (Alarcón et al., 2005)

lack of time for implementing new practices in the projects	Low use of the different elements
lack of training	***Inadequate administration*** of the necessary information to generate a "learning cycle" and to take corrective actions.
Lack of Self-Criticism limits the capacity to learn from errors	***Weak communication and transparency*** among participants
Low understanding of the concepts	***Lack of integration***

As per the above evaluation it is revealed that out of 8 barriers, 6 barriers are related to the Human Capital area. As a percentage, it is 75%.

Table 3.6 to Table 3.15 above presented the evidence of Human Capital barriers in Lean Construction Implementation through this systematic literature review based on the specific *"ten literature on barriers to Lean Construction."* Next, the same evaluation carried out for the rest of the "*forty literatures on Lean Construction Implementation"* is presented below to identify the evidence for the Human Capital barriers. Table 3.16 below illustrates how the barriers identified through these forty literatures are related to the Human Capital area.

Table 3-16: Evidence for other Human Capital Barriers (see Table 3.3 for reference)

Social factors for ***cultural change*** are neglected	Changing organizational ***culture and mindsets*** is difficult.
Environmental factors: pressure from govt market, media, public, supply chain	***Practitioners are focused on "wins" and "proof"*** rather than the management philosophy that is Lean Construction.
Organizational factors: Risk control, resource readiness, enterprise information, supervisor support, ***Lean Culture***, regulations to facilitate the adoption of Lean Construction, Lean Construction ***training***	The most common barrier seems to relate to issues around ***insufficient knowledge. Cultural issue*** is also an often-mentioned barrier
Lack of training	Projects are very autonomous
Lack of motivation employees	***Language and cultural barriers*** prevent creating awareness of lean thinking issues such as training, language barriers, and cultural aspects.
Lack of proper ***problem-solving practices***	***Resistance to change*** Self-criticism Short-term vision
The traditional wasteful approach	Construction ***professionals do not perceive*** the lean construction.
Lack of understanding about lean thinking concepts and their implementation in construction from an organization perspective and cultural barriers	***Conflicts*** were nourished by unpredictability and absence of interest and responsibility concerning the total project performance
Resistance to change.	Focus on short-term goals
In-***group collectivism***	Project participants showed ***reluctance to share information*** and plan.
Cultural interpretations constituted a considerable impediment to process-orientated cooperation in an otherwise traditional project organization	One-of-a-kind products: the lack of repetitive cycles for feedback within a specific project and restricted means for comparison with finished products.
There was not any forum for discussion of lean across the divisions. No common arena for ***exchanging valuable experience and learnings*** from their improvement work	Site productions relate to uncertainty with weather, local labour and materials, problems with coordination of crews around the production site,
No common arena for ***exchanging valuable experience and learnings*** from their improvement work	The ***different meanings are given*** to Lean, its tools, and principles

No ***Human resources management*** practices	Regulatory Authorities: construction projects are subject to approval from authorities,
Temporary Multi-organization: ***poor communication*** among participating organizations, lack of stimulus for long-term improvement, liability issues, and ***inability to accumulate knowledge.***	***Worry about the dehumanizing side effects.*** The employees are exhausted. Unfriendly personnel practices possesses an institutionalized regressive culture of HRM, despite notable exceptions.

Thirty barriers were identified after critically evaluate the identified forty literature on Lean Construction. As per the above evaluation it is revealed that out of 30 barriers, 22 barriers are related to the Human Capital area. As a percentage it is 73%. This is supporting evidence to the above ten specific studies, When evaluating any given number of barriers to Lean Construction Implementation, more than half barriers are related to the Human Capital; skill, knowledge, experience, attitudes, and capacities.

Next, the summary of the Human Capital in the barriers to Lean Construction Implementation and the below figure 3.4 shows the summary of the above findings.

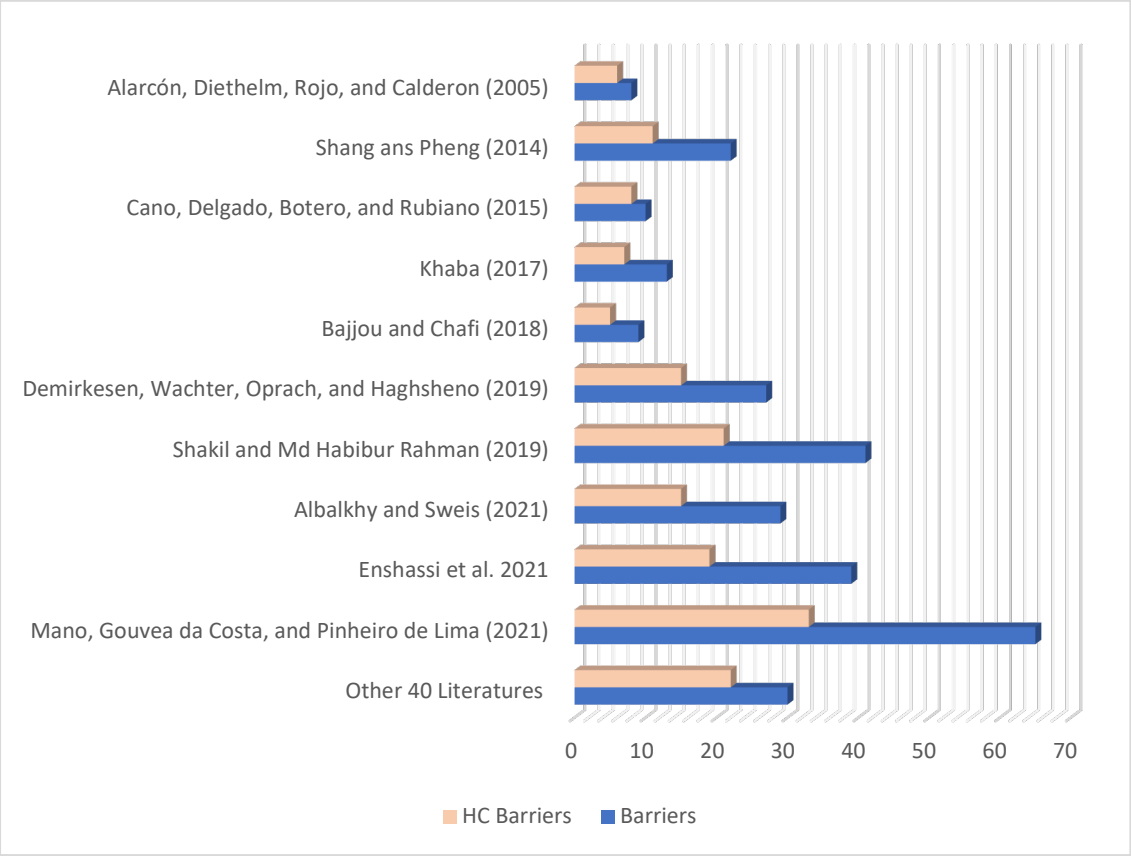

Figure 3-4 Summary of Human Capital Barriers in Lean Construction Implementation

The above graph illustrates that the number of barriers related to Human Capital is always higher than the other barriers. This research aims to develop a framework to improve Lean Construction Implementation from the Human Capital perspective. The following four objectives were used to achieve this aim.

- ✓ To identify the **barriers** to Lean Construction Implementation in the construction industry.
- ✓ To assess the **Human Capital-related barriers** in Lean Construction Implementation in the construction industry.
- ✓ To evaluate the **strategies** for improving Lean Construction Implementation in the construction industry from the Human Capital perspective
- ✓ To develop **the framework** for addressing the Human Capital related barriers in Lean Construction Implementation.

Up to now, objectives one and two have been discussed using secondary data. It is vital to evaluate how Human Capital factors are integral in the barriers to Lean Construction Implementation. Below figure 3.5 demonstrates the percentage of Human Capital barriers from the total barriers to Lean Construction Implementation.

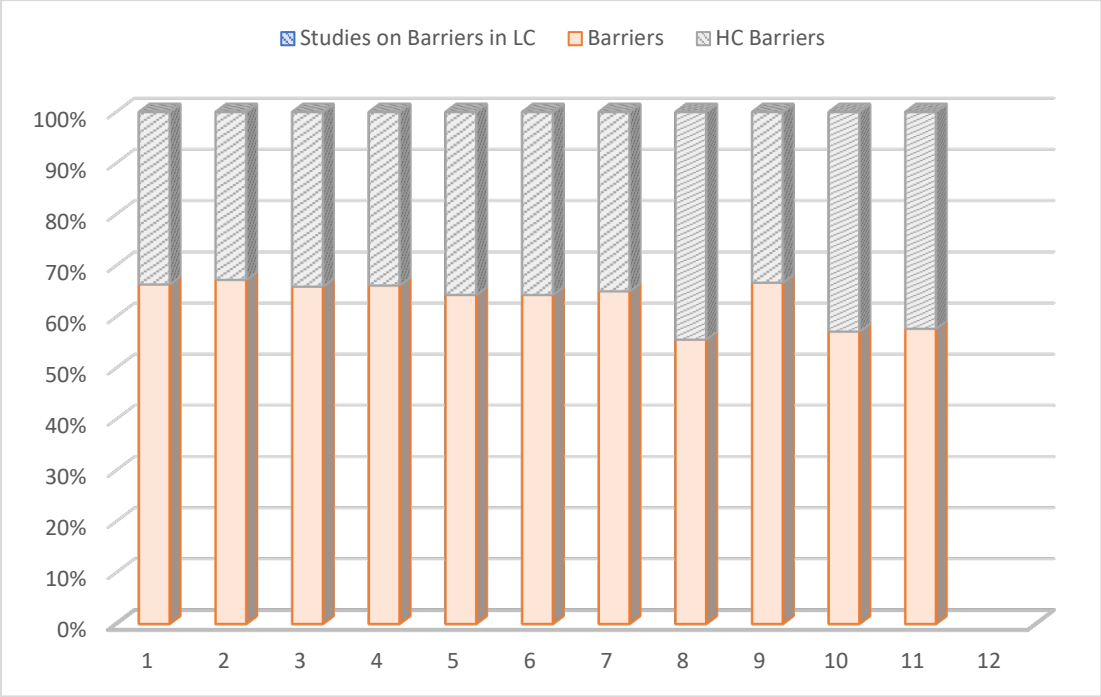

Figure 3-5: Human Capital Barriers as a percentage of the other barriers

These findings clearly show that Human Capital barriers play a major role in Lean Construction Implementation. The next section discusses the most critical Human Capital barriers to identify the strategies to overcome these Human Capital barriers to Lean Construction Implementation.

3.6 Most critical Human Capital barriers in Lean Construction Implementation

As the next step of this systematic literature review, the tabulated lists of barriers were critically assessed to identify the common factors that affected the Human Capital area. Eleven themes within Human Capital were identified when evaluating the barriers to Lean Construction Implementation. The following Table 3.17 shows us the findings of the common Human Capital-related factors in barriers to Lean Construction Implementation. Ten specific literature and the other list of barriers from the forty literature on Lena Construction are named 1-10 and 'other" in this table.

Table 3-17: The most critical Human Capital barriers to Lean Construction Implementation

Human Capital	***Barriers***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***Other***
Awareness	*Lack of knowledge and understanding of Lean Practices*	√	√	√	√	√	√	√	√	√	√	√
Training	*Lack of training/consulting*	√	√	√	√	√	√	√	√	√	√	√
capabilities	*Lack of capabilities (self-criticism, focusing, responsiveness, communication, leadership, commitment)*	√	√	√	√	√	√	√	√	√	√	√
Interest	*Resistance to change /Fear of unfamiliar practices /lack of focus/*	√	√	√	√	√	√	√	√	√	√	√
Attitudes	*Lack of learning from mistakes/ self-criticism/Group culture, attitudes, and behaviour*	√	√	√	√	√	√	√	√	√	√	√
Philosophy	*Lack of awareness of Lean Philosophy*	√	√	√			√	√	√	√		√

Teamwork	*Lack of commitment / responsive to the team, Low level of integration between Teams*		√	√		√	√		√		√
Leadership	*Poor leadership, Lack of support from the top management and Insufficient management skills, and Insufficient management skills*		√	√		√			√		√
Information	*Inadequate administration of information,*	√	√								√
Errors and omissions	*Inaccurate and incomplete work*				√					√	√
Education	*Lack of skills & education*	√	√							√	√

The biggest obstacle to lean deployment was a lack of appropriate lean awareness and comprehension. The next highest listed impediments to lean adoption were lack of technical capability, lack of financial resources, and reluctance to cultural change. To Nwaki et al. (2021). financial barriers, technology and knowledge limitations, culture and complexity barriers, leadership and management barriers, engagement and interpersonal constraints, and communication problems make up the main core of obstacles to the implementation of lean. According to Al Balkhy et al. (2021), the top management's lack of support, poor understanding of Lean Construction, lack of training, and lack of openness are some of the most significant barriers to Lean Construction Implementation. The "lack of applying the concept of design constructability," "limited use of design-and-build procurement," "management resistance to change," "lack of a long-term philosophy and planning, “lack of incentives and motivation and poor professional wages," and "incorrect or misleading designs," were significant additional barriers (Balkhy et al., 2021).

Lack of leadership and empowerment of people in the project (Alarcon et al. 2005), Lack of a clear explanation of the scope, value, and definition from the perspective of the consumer (Sarhan y Fox 2012), Lack of long-term planning for Lean adoption in the organization (Shang y Sui Pheng 2014), Insufficient communication across teams, vendors, subcontractors, to mention a few (Demirkesen et al. 2019), Reduced Lean dependability due to lack of open communication between team members and management. 2020 (Liu et al.) and lack of comprehension of the major motives of implementing Lean. In 2020, Walter et al. Resistance

to change of people in the organization (Murguia 2019), Effortless communication from senior executives on improvement projects. (Almanei et al., 2017).

In the above sections, the barriers to Lean Construction Implementation were identified and the relationship between barriers and Human Capital were examined. It is revealed that more than half of barriers are related to Human Capital of the employees in the construction industry. The next section discusses the widely suggested strategies to improve Lean Construction Implementation from Human capital perspective.

3.7 Widely suggested strategies to improve Lean Construction Implementation

As the next step of the systematic literature review, the suggested strategies to overcome the barriers in Lean Construction Implementation were identified based on the literature selected for this systematic review. According to Green (1999), the application of lean methods depends upon the hegemony of management over labour development of the industry's intellectual capital. According to him, the Lean concept was first started by Toyota Production System in Japan in around 1970s and its success was made possible based on the managements' total enforcement. In later decades, the West and the rest of the world adopted a more liberal form of implementation of Lean Construction Implementation strategy.

The victory of lean, as described by Green (1999), and the success of the lean practice in manufacturing, stimulated many researchers and practitioners to work to imitate the experience of lean in manufacturing in other sectors, construction inclusive such as aerospace, metal processing, construction industry, and even in services. In early 1992, lean practice started finding its way into the construction sector, as Green (1999) cited. In the early adoption of Lean Construction, the Transformation-Flow-Value theory, which has three core concepts, formed the basics of a successful Lean Culture implementation in organizations. These core concepts of TFV are Transformation – which is basically transforming the inputs into outputs by decomposing the work into tasks, then reducing the cost of these undertakings so as to realize the efficacy of the added-value activities. Flow – the flow of materials and information, in addition to transformation, includes inspection, moving, and waiting. The main aim of flow design and improvement is to reduce the wastage of non-added value activities. Value – value is generated from the customers' viewpoint by ensuring the understanding of the needs of the customer as well as the fulfilment of these needs.

For Coffey (2000), two aspects of human resource management, upon which Lean Construction is dependent, are the commitment and involvement of workers, both essential contributors to many of the functions of Lean Construction.

According to Coffey (2000):

1. A desire to participate must be entrenched in the worker's attitude. Without the desire to be fully involved in the process of Lean Culture, its implementation will be difficult across the organization's hierarchy. While Green (1999) believes that there is need for top managements hegemony in the implementation of Lean Culture, Coffey (2000) insists that there must be a desire to participate in Lean Culture development within the workers (Forbes & Ahmed, 2020).
2. A need for independence is important in making Lean Culture a success. The ability for workers to have opinions on projects; contribute to how their part can be improved without making other people in the team less worthy of having opinions is important for a successful Lean Culture implementation in an organization (Kumar et al., 2022).
3. A desire to make decisions closely follows the need to be independent. The ability to allow team members to make decisions on projects gives them a sense of belonging. This entrenches Lean Culture development, implementation, and success (Forbes & Ahmed, 2020).
4. A semi anti-authoritarian attitude of the leaders of Lean Culture is important. As a rule, not everybody will key into the Lean Culture or attitude adjustment, irrespective of how the top management has tried to accommodate the workers (Nwaki, Eze, & Awodele, 2021). In this manner, there is a need for the Lean Culture leader to have some hegemony and authority over the process and implementation of the Lean Culture amongst the staff.
5. Goal convergence between worker and company must be aligned Coffey (2000). The lean leader must be aware that for a successful implementation of Lean Culture in the organization, the worker must see how his role will benefit not only the company but how it will benefit him too (Forbes & Ahmed, 2020). If there is a misalignment between the worker's goals and the company's goals, there will be resistance. Resistance will lead to the chaotic implementation of Lean Culture (Kallassy & Hamzeh, 2021).
6. A basic trust in the company and its motives by the workers must be there Green (1999). Overall, an effective, deliberately designed system of human resource management will produce the high levels of employee commitment and involvement needed (Forbes &

Ahmed, 2020). Therefore, for a successful Lean Culture and construction, the workers must have the mindset that the company will not let them down.

Further, Green (2000) stated that Lean Construction is considered from a human resource management perspective. The construction industry's ingrained culture of hard human resource management, that is, Best Practice = Better Profits. Green (2000) advocated for organizations to:

- Find out more about the relationship between Best Practices and Better Profits. This will help them in overall improving profit levels.
- Learn how to increase efficiency, reduce costs, and improve competitiveness across all boards.
- Hear, first hand, from organizations that have benefited from implementing Best Practices. This is important as they will learn more about the "dos and don'ts" involved in Lean Construction.
- Discover the bottom-line benefits of putting the theory into practice. As Green (1999) pointed brought up, the importance of the theory, there is put the TFV into practice (Green, 2000) for a successful Lean Construction and Lean Culture in the organization.

In addition, Seymour & Rooke (2001) agree that Lean Construction is a radically new way of thinking about the construction process. To engineer its adoption means questioning assumptions, ways of thinking, and practices of the existing culture - into which people have long been schooled. Therefore, efforts have been made to understand the existing culture; to establish the reasoning and rationales it embraces to change it. They suggested that managers and Lean Construction leaders must walk the floor, listen to what people say, should not jump to conclusions, or project their own fears and inhibitions onto others and so on. What they have tried to emphasize here is a mode of analysis that is revelatory – carefully exploring what is there rather than foreclosing it by applying a priori assumptions and categories. Using this method in specific circumstances may be expected to reveal possibilities otherwise hidden. Although the hegemony of the top management is advocated for a successful implementation of Lean Construction, there is a need to also have a human-face interface with the hegemony. Construction managers must get to the site and have a feel of what the linesmen and foremen

are going through. This builds trust and empathy among them. The result is an easier implementation of Lean Construction without much resistance.

Again, Almeida & Salazar (2003) agree with the opinion of Seymour & Salazar (2003) that Lean Construction implementation requires top-to-bottom change in both culture and attitude, with emphasis on the multi-organizational effort to share a common purpose. The importance of altering the existing company culture and attitude overall is key if Lean Construction is to be widely adopted wholeheartedly by the workforce. Without a holistic change in attitude and culture, there will be a few fewer sustainability managers/leaders can to improve Lean Construction in a construction firm. They affirm that without a clear shift in the attitude of the top management – especially the proponents of the Lean Culture, the adoption or implementation among the staff will be difficult. This must not only be in the attitude or behavior in front of the staff or within the company premises. It must also be the same outside of the company's premises. This will let the workers know the seriousness and gravity of the management's position and consequently fall in line. The outcome is a better and easier Lean Construction or culture implementation.

Following, Alarcon et al. (2005) believe that working in a collaborative approach, with different training actions, and sharing experiences and information among the companies contribute to a better working experience as well as in Lean Construction. For the authors, adequate collaboration among companies in the same industry (i.e. construction) will benefit more when information and experiences are shared, rather than hiding or hoarding information such as Lean Construction. They urged construction companies to be open with information on Lean Construction as this will also help them benefit from other companies with superior information on the same subject matter. They also encouraged companies to be more liberal with such information that will improve the overall Lean Culture in their organization. Without information dissemination among the company hierarchy, there will be trust issues and high-level resistance among the workers in that organization. With easy dissemination of information –especially as regards Lean Construction and Lean Culture, it becomes easier to build trust between the staff and top management. Implementation of Lean Construction becomes smoother and more successful.

In his opinion, Cameron (2005) states that problem-solving people and partners process philosophy in a largely similar way. Problem solvers and partners' processes, as stated by the

authors, can and do implement Lean Construction in such a manner that there is little or no friction in the workforce. They believe that there is a growing realization of the importance of leadership in Lean Construction. In support of Cameron's opinion, Pavez & Alarcon (2006) believe that lean leadership, enterprise vision lean vision, technical capacity, management capacity, and social competence are important aspects any company must focus on if they intend to implement lean construction successfully. These qualities are a must, as a lack of any of them will impair the implementation of the lean agenda. Organizations whose managers lack these qualities either need to train them or hire people who have the desired qualities to lead Lean Construction.

Also, Neto & Alves (2007) believe that making employees understand lean concepts and convincing suppliers to adopt the lean philosophy is the first aspect of Lean Construction culture integration. Motivating the efforts to assimilate concepts through readings and courses about Lean System goes a long way in making Lean Construction a success, as well as changing the employees' mindsets. It also makes the top-level management participate more effectively in the Lean Culture implementation. It's important to soften the bureaucratic and hierarchical levels so that top management gets involved with the changes and involves workers in the change process. With less top management being convinced of the need to have Lean Culture or Lean Construction, it will be difficult for the lower-level staff to also have that conviction. The organization must ensure that the training is not limited to any strata of the organization (Top, Middle, or Lower) managers; it must be for every single person working there – from janitors to the CEO. All of them have critical roles to play in the successful implementation of Lean Culture in the organization.

Moreover, Chesworth & Gejendran (2010) strongly believe that Human Capital is one of the most significant assets of any organization. Construction industry problems associated with productivity, efficiencies, and waste can be linked in some way to human behaviors. Interpreting culture as a collective or collection of attitudes; ranking and guiding organizations to a particular cultural outcome; analyzing cultural change on scales of maturity and immaturity; viewing cultural change as generalist zones of understanding; and viewing cultural change as a series of centric circles are all important in understanding how successful Lean Culture and Lean Construction can be in an organization. As the authors pointed out, poor human resource management and sloppy human resource policies will lead to the failure of Lean Culture and Lean Construction. The people involved must be brought into the vision and

mission, the goals, and the objectives of the organization. They must be convinced that their input will make a huge difference, not only in the company but in their lives. When the people are adequately convinced of their importance in the Lean Construction process and Lean Culture, they are more encouraged to put in their very best. This usually makes Lean Construction and Lean Culture very successful.

Wandahl's (2014) opinion agrees with that of Chesworth & Gejendran (2010) that changing traditions and culture seems to be a necessary prerequisite for implementing Lean Construction. Without this, the success of Lean Construction may be limited to the tenure or project of the top management spearheading it. Therefore, the need to have a sound HRM complemented by a sustainable lean leader will lead to easy Lean Culture implementation. Organizations that have found it difficult to implement Lean Culture or manage its implementation has HRM problem at the root cause. Poor human resource management causes resistance and sabotage of company goals, vision, and mission. Once human resource management issues are resolved, it becomes easier for Lean Culture Implementation.

Equally, Delgado et al. (2015) state that critical success factors such as participation of all stakeholders, easy flow of information, and sharing of experiences are a much better way to implement Lean Construction in a construction firm. Again, coordination and cooperation; overcoming resistance to cultural change; change in the mindset of employees; motivating people to change; teamwork; development and selection of the right people; honesty and trust among participants - transparency; effective leadership; training and appropriate education – all lead to a successful Lean Construction Implementation. As Wandahl (2014) suggested, there is a need to have proper working as well as effective leadership in the organization for the implementation of Lean Culture. When any of the listed leadership qualities and processes are missing from the organization, it will be extremely difficult to have a successful implementation of Lean Culture in the organization. Therefore, Delgado et al. (2015) and Wandahl (2014) believe that effective leadership will greatly influence positive Lean Culture in the organization.

Ebbs et al. (2015) believe that Community of Practice, the promotion of Lean Construction (getting the message out there), motivation, and the effect of lean on employee wellbeing (H&S), employment, and attrition. Culture Trust, Blame, Problem-solving Conflict resolution, Synchronized action, etc., lead to the effective and efficient implementation of Lean Construction. As Mossman (2015) found out, Lean Construction Leadership development

skills & knowledge are required to lead a lean transformation. Big room/co-location; construction & design; Last Planner; lean project delivery; lean thinking and flow; learning & theory of knowledge appreciation & understanding of, and skills; choosing By Advantages; coaching; consultancy; decision making; facilitation; leadership, including servant pre-fabrication, production theory, psychology, systems, target value design, Training within the industry, variation, leadership, managing change, personal and organizational learning, process mapping, production planning, management, reliable promise, running simulations, training & instructing are all parts and parcel of successful Lean Construction implementation.

In their study, Salvatierra et al. (2016) found that a gap associated with human resources management, where practices such as talent management, incentive structure, measurement system and performance evaluation are largely ignored, Lean Construction experiences more barriers in implementation. Khaba (2017) found that cultural differences are found to be the most important barrier, whereas resistance to change and lack of performance measurement systems are found to be the least significant barriers. The model would help the decision-makers, researchers, and practitioners to prioritize the focus on the barriers which mitigate their leanness and ultimately constrain their success before practical implementation. Thus, it would help to propose strategies for eliminating or minimizing the barriers to implementing Lean Construction and better utilizing their resources for productivity improvement.

As Mohammed et al. (2018) stated, the development of appropriate strategies is designed to overcome such obstacles, especially those concerning people-related barriers such as lack of knowledge about the Lean Construction concept, resistance to change, unskilled human resources, and lack of commitment from top management. Torp et al. (2018) concluded that the implementation should follow the line from top organizational management down to its divisions and further into construction projects. Establishing a learning forum across the organization is highly recommended.

Adnan et al. (2019) also found, from their studies, that to reconsider their attitude towards using Lean Construction techniques, there is a need to ensure the culture, attitude, and behavior of all the parties involved are changed towards achieving the company's goals. As Ghannoum et al. (2019) stated, radical changes to their way of thinking, traditional methods and organizational structures are keys to achieving the required Lean Construction culture in the organization. Jamil et al (2019) looked at it from a different point of view. They concluded that

critical success factors such as autonomous, linkage, dependent, and driving clusters are the keys to the effective and efficient implantation of Lean Construction. Implementing organizational change (Culture, strategy, vision, and performance evaluation system) is very much required to ensure the success of Lean Construction.

Poshdar et al. (2019) also opine that an in-depth understanding of the decision mechanism that drives changes in an SME seems to be necessary. Organizational Structure, Leadership, Management Style, Operational Improvement, Human Resource, Networking approach, Innovation is the background of what Lean Construction requires to be successful. For Sarhan et al. (2019), corporate social responsibility, Positive impact on the environment, Right things to do, Moral and ethical obligations to preserve resources for future generations, and Moral role in contributing to the sustainable development of the planet form part of a successful Lean Construction. Heyl & Demir (2019) believe that cooperation and communication between the individual project participants make a positive contribution to social management. Wu et al. (2019) state that the influence of management commitment, Culture, and feedback on safety performance improves behavioral efficacy in construction safety management and ultimately promotes the adoption of lean construction tools and the Lean Construction implementation process. For Cano et al. (2020), people are essential for the production and implementation process. In the construction project, all operations are carried out with people who constitute work teams, and the team's work builds their work environments. In this way, companies must concentrate their efforts on the formation of Human Capital to build a Lean Construction culture.

Li et al. (2020) believes that the willingness to adopt the implementation intention: Enterprise size & ownership, Information level, Knowledge, Organizational structure & culture, and market factors contribute immensely to Lean Construction success. Walter et al (2020) concluded that the Lean Leadership model, People, Culture, and Change: Lean Leadership and Capability Building: Lean Leaders in Construction, makes Lean Construction Implementation important and key. Without these, its implementation will be limited.

In summary, the literature analysed above to identify the suggested the widely used strategies to develop a Lean Culture as the solution to overcome the barriers to Lean Construction Implementation. For Lean Construction and Lean Culture to be successful, organizations must ensure that they are committed. Lean leaders must be visionary, capable, committed, and

desirous to see the success Lean Construction in the organization. He must also have the interest of the workers at heart for a successful Lean Culture to be adopted in the organization. The literature reveals that to improve Lean Culture from Human Capital perspective, there are key areas the organization must address holistically. According to the literature findings, Lean Culture improvement is summarized in figure 3.6 below.

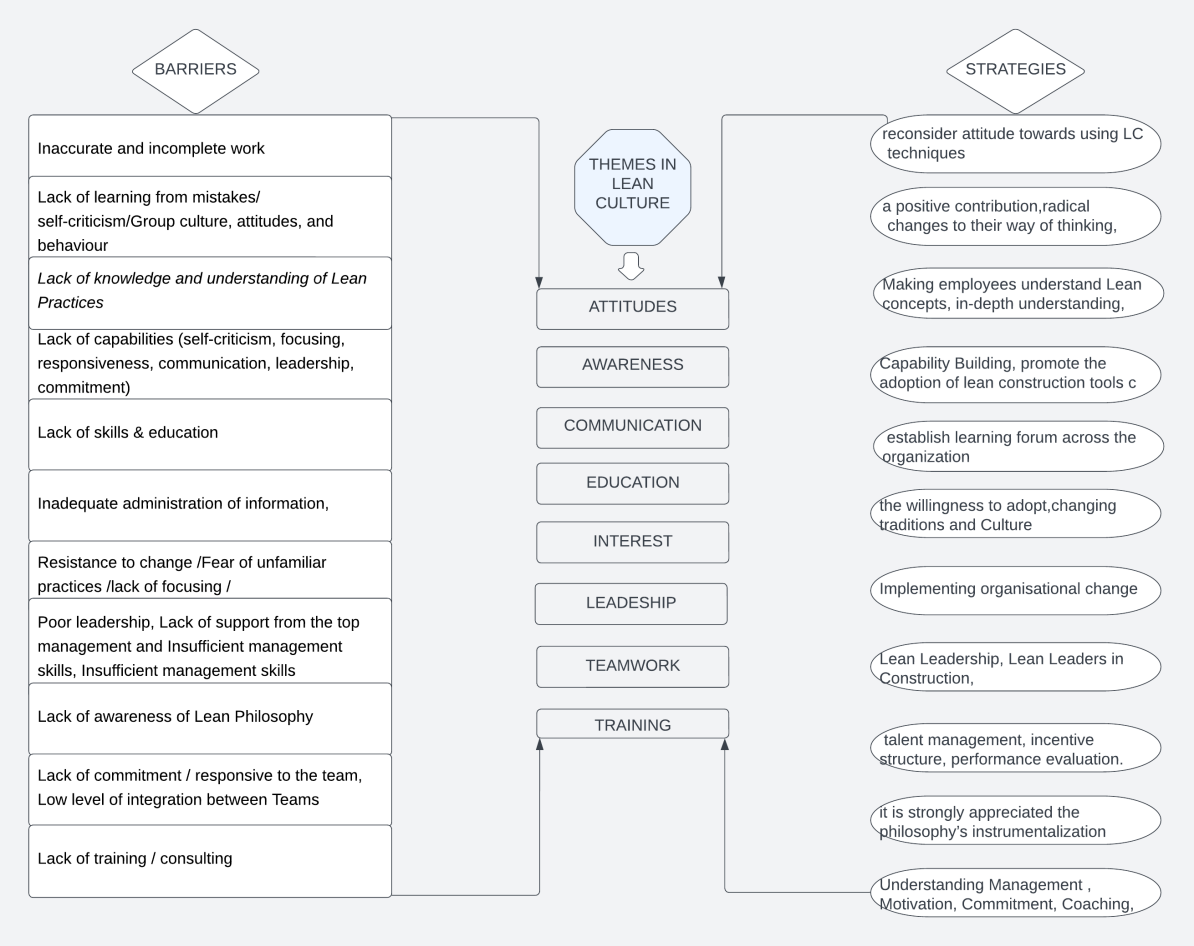

Figure 3-6 Themes to improve Lean Construction Implementation within a Lean Culture

The above flowchart in Figure 3-6 illustrates that the Lean Culture is the center for the existence for barriers and the strategies to overcome them. Therefore, developing the lean Culture is discussed next.

3.8 Developing a Lean Culture in an organization

Lean Culture in an organization involves creating a conducive working environment where employees focus on waste reduction, continuous improvement in the working process, and customer value. According to Keiser (2012), several practitioners who have implemented the Lean Culture in their organizations have experienced lower costs, shorter schedules, improved

safety and better quality. He opined that the practitioners of Lean Culture believe that the degree of success in their organizations is closely related to how much they have adopted the Lean Culture. Respect for people and continuous improvement are the basic principles of Lean Culture (Keiser, 2012). However, to effectively implement Lean Culture in the organization, additional steps will be needed to instil the values of mutual respect and continuous improvement in work processes because many of the employees have held opposing and long-established beliefs and attitudes.

For Lichtig (2010), there is a need for a lean transformation if there is a successful lean journey. Lichtig (2010) believes that project characteristics vary widely, the same as project teams. As a result of these, there is a challenge for those who push, provide or support lean function or culture. Some companies failed in their desire to implement Lean Culture due to the inability to foster company-wide transformation (Keiser, 2012). For Lean Culture to be successful, leaders must visibly lead the change. It is not going to be by proxy, although the assistants are there to help in the journey. However, it is required that the Lean Culture leader must be totally involved and committed to the project. His commitment must be followed by a steady effort to align the organization with the Lean Culture. The Lean Culture must involve the company hierarchy and continuous improvement. At the onset of setting up a lean system, consultants are usually hired to help expedite the process. Such consultants can be internal or external. Aside from leading the change from the front and the provision of the required resources, other steps identified in the process of creating Lean Culture are outlined herein.

According to Sarhan & Fox (2012), training should be just-in-time. People working on a project should already have the required lean training. They observed that in the UK, three important things issues determine if an organization is ready for Lean Culture or not. These are the level of lean awareness across the organization, the level of management commitment, and the existing culture and human attitudinal issues which may pose a major resistance to the implementation of Lean Culture. Successful Lean Culture requires a change in behaviour and attitude. Since a behavioural change cannot be enforced, there is a need to have skilful management and leader who can influence their people towards Lean Culture adoption. Again, set a clear vision and communicate it. Macomber & Howell (2005) maintains that a shared vision brings stakeholders on the same page. Eric (2022) agrees that Lean adoption requires significant and ongoing support from the highest levels of an organization. He believes that “a successful lean deployment is 20% dependent on tool expertise and 80% dependent upon the

leadership and culture in which they are utilized." Lean starts at the top, and developing a clear vision for creating a Lean Culture is the first of many steps that executives must take to ensure success. A clear and concise vision is important to developing a Lean Culture. The organization's vision should focus on delivering value to the customer while eliminating waste and creating a culture of continuous improvement. Ensure that everyone in the organization understands the vision and their role in achieving it. The workforce usually aligns itself with the vision and values set by the leader. This is also based on beliefs and a positive view of the future.

Further, a successful Lean Culture will provide training and resources. Adequate resources must be provided by the organization – training, facilitation, equipment, and key information. Eric (2022) goes further by stating that creating a Lean Culture starts with a vision, but in order for Lean to become a way of life, there must be practical steps taken. There are many tools for success that a company can highlight. A Kaizen Blitz – a concentrated and intensive workshop that looks at process improvement – is oftentimes a great place to start for training purposes. This can be followed up with an established 5S practice (Sort, Set, Shine, Standardize, Shine) to help efficiency and organization and a look into A3 methodology to provide a simple and strict guide for problem-solving. With Lean being, in its very nature, a continuous improvement approach, training will be revisited again and again to ensure a strong foundation. Employees need the necessary tools and knowledge to implement lean principles effectively. Provide training sessions and resources to help employees understand lean principles, tools, and techniques. There is also the need to encourage them to participate in workshops, conferences, and other educational programs to help sharpen their skill sets and improve their work productivity.

In addition, empowering employees is another important success point in Lean Culture implementation. Empower employees to make decisions and take ownership of their work. Management and managers are also encouraged to allow employees to report mistakes as well as learn from their mistakes. Therefore, encourage them to identify problems and come up with solutions to improve processes. This promotes a sense of ownership and accountability, leading to better results. More so, companies must ensure they foster effective collaboration among the company hierarchy. Foster collaboration among teams and departments to promote a shared understanding of goals and objectives. This helps employees identify opportunities for improvement and work together to implement changes. Following, focusing on the customer's

needs is a great way to actively develop a buy-in culture. Employees should engage in collaborative partnerships with customers, sharing ideas and seeking out new ways to continuously improve the process. This develops a sense of pride from the employee, who delivers a superior product, and a sense of satisfaction and value from the customer, who receives exactly what they want because there was a collaborative nature to the process.

Data accuracy makes the measurement of progress easier and more reliable. Organizations must set up a system to track and measure progress toward lean goals. Periodically review performance metrics, such as cycle time, lead time, and defect rates, to identify areas for improvement and ensure these areas are constantly improved on. Celebrate successes and use failures as learning opportunities. Practice continuous improvement. Continuous improvement is the core of a Lean Culture and entrenches character and accountability in employees. Encourage employees to continuously evaluate and improve processes as well as challenge processes to see as being inimical to the success of the organizational goals. This promotes a culture of learning and experimentation, leading to sustained improvements over time.

To conclude Lean Culture is important for organizations that want to excel, stop wastages, and continuously improve. Leading change successfully requires several necessary actions, as stated by Macomber & Howell (2005). Construction teams and project managers need to be guided in adopting new attitudes and behaviour to deploy and implement lean construction across their teams. Several specific actions have been identified and explained in this regard: shared vision, continuous improvement, data accuracy, effective collaboration, behavioural change, training and provision of adequate resources. An approach has been shown that organizations can adopt as a strategy to bring lean transformation to their organizations. The approach consists of building capability in the teams from the bottom up that is complemented by having management drive continuous improvements from the top down. Each approach complements the other and together, they help migrate the organization from its current state to a leaner organization that drives continuous improvement. Over time, this would build a culture of lean in the organization. The approach is practical and simple. It is prescriptive yet adaptive to various organizations. The approach is generic enough for adoption both with the management and employees.

Creating a new culture in the workplace requires an identity shift. Committing to Lean practices and reaping the full benefits of a continuous improvement approach largely depend on

leadership setting the tone. If the buy-in is real, and all company areas are focused and held accountable to the process, then a Lean Culture can become a Lean way of life for any size manufacturer. In a nutshell, making is a way of life. In this way, construction companies must concentrate their efforts on forming Lean Culture to build the Human Capital to improve the implementation of Lean Construction. As a high priority and necessity, the government and other professional organizations within the construction industry should give more importance to capacity building, innovation, and knowledge creation through lean principles; this would help create the necessary paradigm change to engender Lean Construction Implementation. Additionally, strong management and leadership support are required to integrate Lean Construction practices into the operational culture of construction organizations (Nwaki et al., 2021). Management of construction enterprises must take the initiative in change and implement new practices that might boost industry performance and efficiency. Further, management should encourage employee engagement and creativity by offering training programs, encouraging, and enabling them, and valuing their comments.

The next section presents the conceptual stage 2 developed after the carried out the systematic literature review.

3.9 Conceptual Framework -Stage 2

This research aims to develop a framework to improve Lean Construction Implementation from the Human Capital perspective. The secondary and primary data were collected to achieve this aim, and the secondary data was collected in three different stages. First, a preliminary literature review was conducted to describe the research gap with the background of the research. Secondly the barriers to Lean Construction Implementation are identified through a detailed literature review (see Chapter two). Also, a *"conceptual framework stage 1"* was proposed with the intention that this conceptual framework could be improved with a systematic literature review. Therefore, the third phase of secondary data collection was to carry out a systematic literature review to identify the most critical barriers to Lean Construction Implementation from Human Capital perspective. Furthermore, strategies to overcome these barriers were evaluated. This chapter presented the findings from the systematic literature review, and figure 3.7 below shows the conceptual framework stage 2.

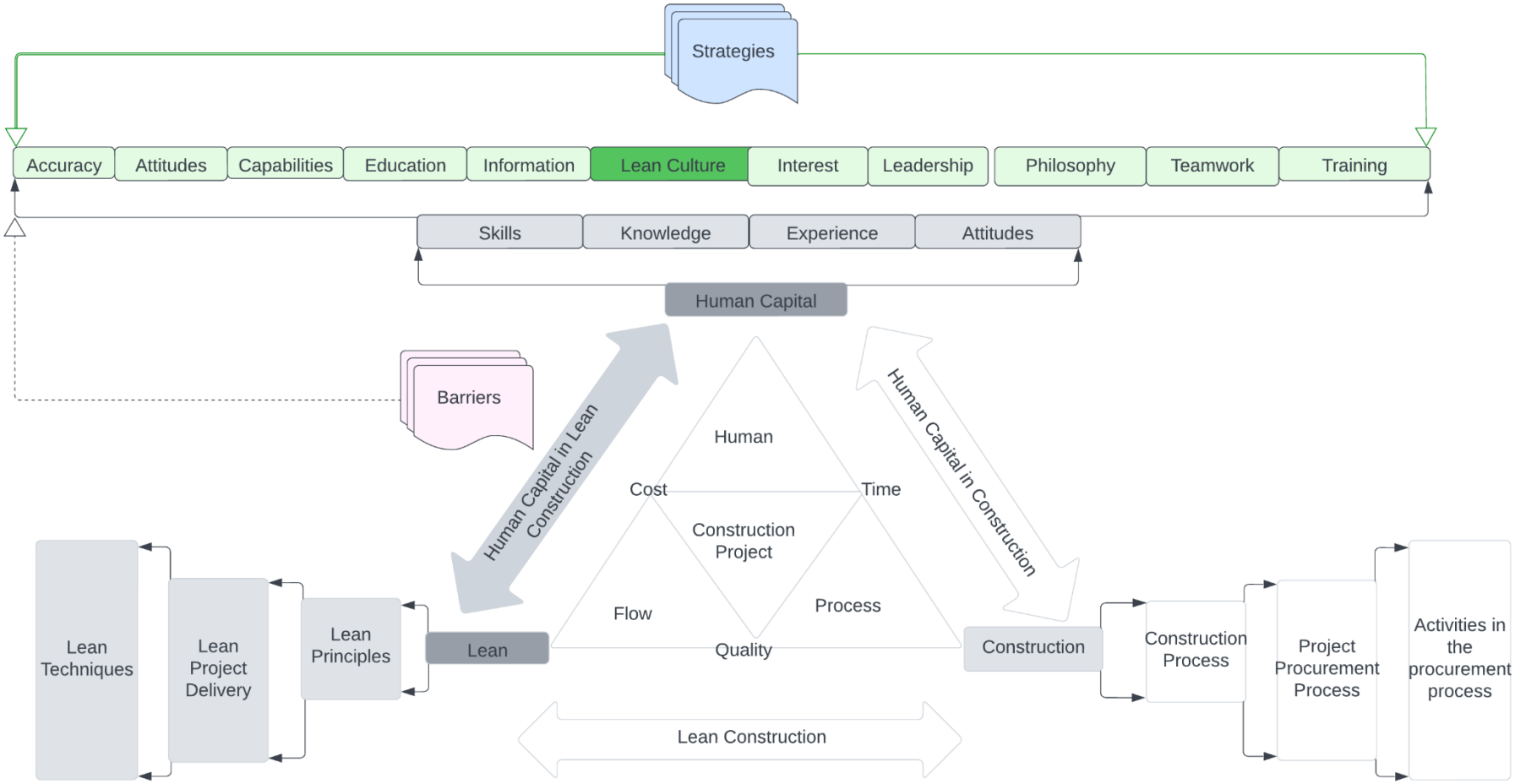

Figure 3-7: Conceptual framework - Stage 2

The conceptual framework stage 1 (see section 2.5 and figure 2.2) demonstrates the basics of Human Capital, skills, knowledge, experience, and attitudes. The conceptual framework stage 2 above, the Human Capital area, was more detailed adding the key theme of "Lean Culture" and the sub-themes under Lean Culture associated with accuracy, attitudes, awareness, capabilities, education, information, leadership, philosophy, teamwork, and training. As the next step of this research, the primary data was collected to develop the framework to improve the Lean Construction Implementation from Human Capital perspective.

3.10 Summary of systematic literature review

This section's systematic literature review underscored numerous barriers to lean construction implementation. For instance, Mano et al. (2021) identified 65 internal barriers. However, they categorized them by stating that Cultural-related barriers include lack of commitment to the team, difficulty in focusing the business on the customer, resistance to change from the fear of unknown practices, and seeing the new with skepticism and pessimism. Leadership Barriers are difficulty getting support and commitment from top management, resistance to change by the leadership, centralization of decisions and the challenge of establishing participatory management, and insufficient knowledge of managers to manage the change process. Structural aspects Barriers are the inability to measure project progress. Albalkhy and Sweis (2021) identified 39 barriers and categorized them into management, financial, educational, governmental, technical and human attitudinal barriers.

To Shakil and Rahman (2019), there are 41 barriers in Lean Construction Implementation, and the highest-ranking challenges are the lack of awareness about lean construction, lack of skills, training and lean techniques, unwillingness to change the existing culture, lack of management commitment, and fragmented and cyclic nature of the construction project and unavailing communication between all project participants. Demirkesen et al. (2019) identified 27 barriers. They also stated that the highest-ranking barriers were lack of 'top management support,' 'misperception about Lean practices', and 'lack of information sharing and integrated change control. Within this study, the barriers to Lean Construction Implementation were identified into different groups such as political, economic, technical, workforce, cultural, managerial, and

communication. Results indicated that the socio-cultural background could be the most important barrier. The most critical barrier in Bajjou and Chafi (2018) work is a Lack of knowledge about Lean Construction practices; the second highest is Unskilled Human Resources. However, to Khaba (2017), cultural differences are the most important barrier to Lean Construction.

Interestingly, Cano et al. (2015) submitted that the most critical barriers include difficulty in having appropriate people for Lean Constructions' application. Shang and Pheng (2014) believe that the most crucial barriers to implementing lean practices include 'their lack of long-term philosophy,' and "the absence of a Lean Culture in their organization. Notwithstanding, Alarcón et al. (2005) argued that the key barriers are lack of training, lack of organizational elements to respond to Lean Construction Implementation, and lack of self-criticism. Although the literary works' perspectives of the specific factors that comprise the most critical barrier to lean construction implementation, it is safe to conclude that human-related factors significantly affect lean construction implementation. In the next Chapter, the primary data collected through semi-structured interviews are presented with analyzing the data.

The key question of this research is how to improve Lean Construction Implementation from a Human Capital perspective. The next chapter discusses the research design of this study, including the methodologies used to collect and analyze the primary data.

CHAPTER 4 RESEARCH DESIGN AND METHODOLOGY

4.1 Introduction

The approach used to establish the tools and strategies for conducting quality data and analysis search is discussed in this section. Table 4.1 below illustrates the themes of the content covered under each sub-heading.

Table 4-1 Chapter 4 Research Design & Methodology

Section headings	Section content
4.1 Introduction	The content of the chapter is presented in this section with a flow chart to illustrate the key elements of the methodology.
4.2 Research Design	The research onion framework is presented with a description of the pragmatism research philosophy used for this study.
4.3 Research Techniques and Process	The data collection approach and the data analysis techniques are discussed for both Interviews and Expert opinions for validation, including data triangulation, validity & reliability. Further, this presents the details of ethical and legal issues.
4.3 Data Collection Approach	A deductive research approach is used for this study. Both secondary and primary data collection are discussed.
4.4 Summary of the Research Design	This section summarizes the research design for this research.
4.5 Research Methodology	This section presents the methodology carried out to achieve the aim and objectives of this study. Preliminary literature review, detailed literature review, systematic literature review, semi-structured interviews, and experts' opinions for validation are discussed.
4.6 Summary of the research methodology	This is the section that presents the summary of the methodologies with its steps processed with a graphical representation.
4.7 Chapter Summary	Chapter 4 is summarized with the introduction to Chapter 5.

First, the research design is discussed, and then the methodology adopted for the research is detailed. The research onion framework (Saunders & Lewis, 2018) was used to design the research. The discussions based on the research onion, including data collection approach, primary study, participant selection, data analysis, data triangulation, validity and reliability, ethical, legal, and social issues, as a summary are presented under each heading in this chapter. Also, they are depicted in the following flow chart shown in the below figure 4.1.

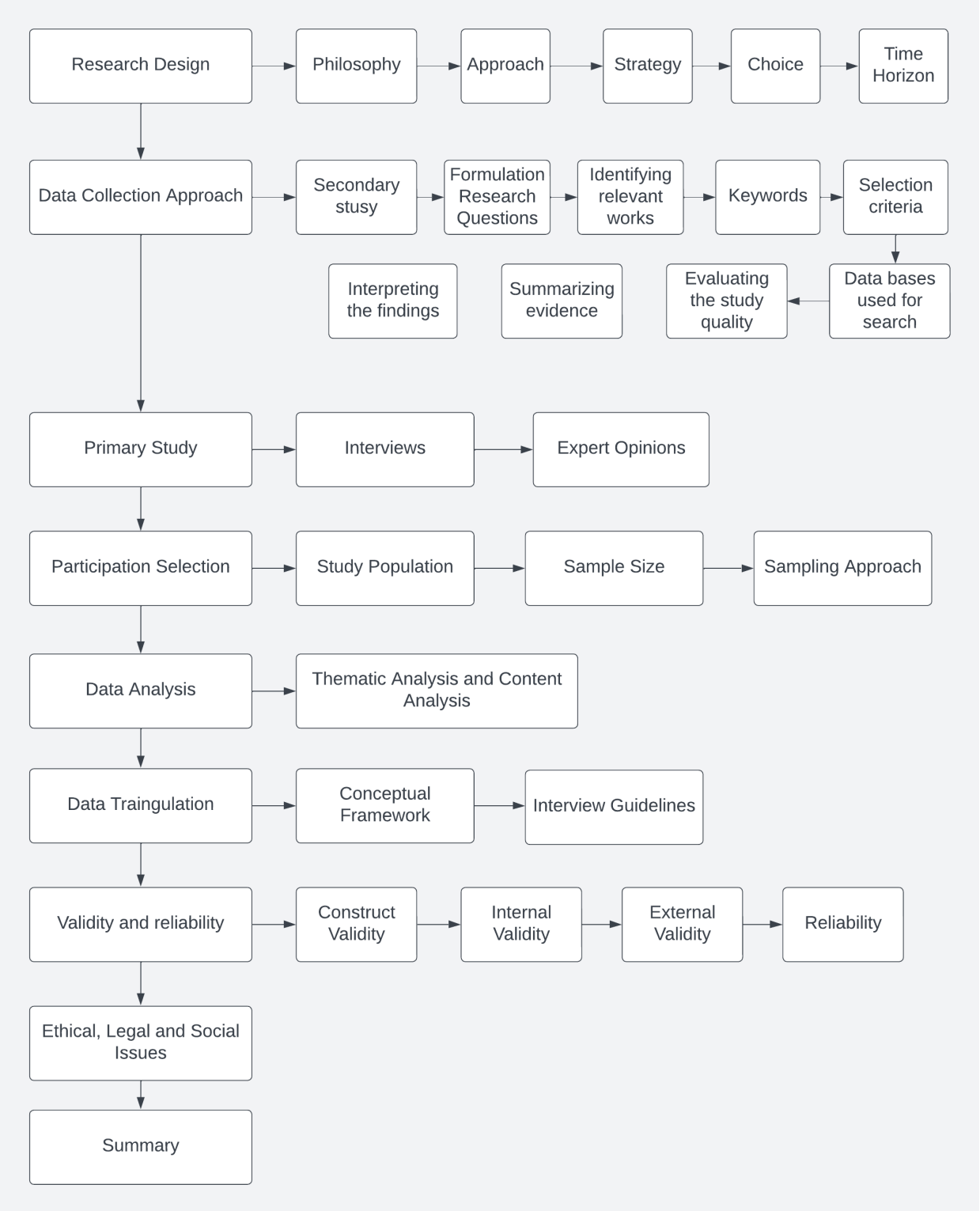

Figure 4-1 Research design flow chart

The next section presents how these elements in the above flowchart are applied to this research to answer the research question; how to improve lean construction implementation from a Human Capital perspective.

4.2 Research Design

The framework of this research is the research onion approach (Saunders, Lewis, and Adrian, 2009) developed a framework that describes the steps that must be followed to perform a sound research methodology. Research Onion is a framework intended to enable researchers to undertake research work quickly and streamline and classify the data obtained for the research (Melnikovas, 2018). Additionally, it shows the procedures for describing a methodological investigation (Saunders and Lewis, 2018). The below figure 4-2 illustrates the onion approach.

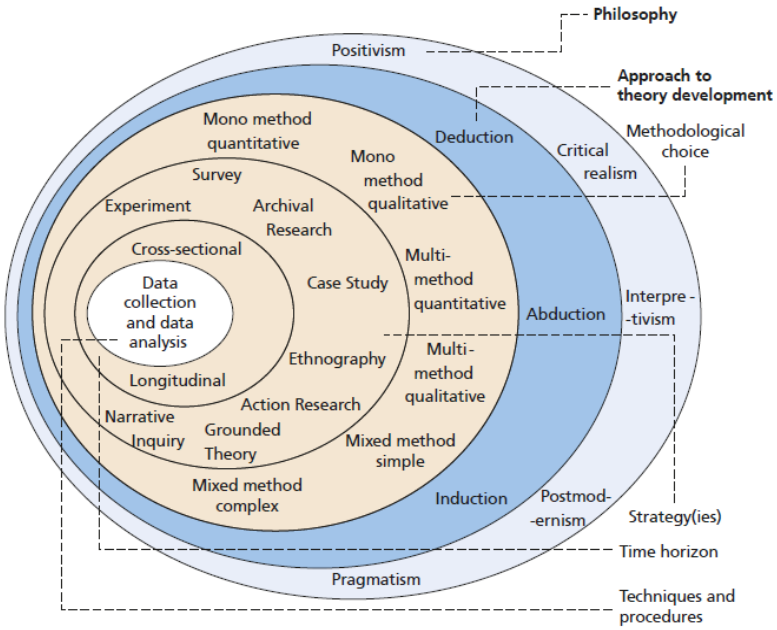

Figure 4-2 The research onion (Saunders and Lewis, 2018).

As indicated in the above figure 4-2, the six layers of the research onion are research philosophy, research approach, research strategy, research choice, research time horizon, and research

techniques and processes. According to (Saunders and Lewis, 2018), a research onion is used to research, starting with the topmost layer, the research philosophy layer, and the technique and procedures layer. A brief overview of how the data for this work was gathered is offered. According to (Melnikovas, 2018), the research onion method has its starting point with the delineation of the main philosophy, choosing approaches, methods, and strategies as well as defining time horizons, which altogether take the research logic to the research design – main techniques and procedures of data collection and analysis. This framework has a powerful multidisciplinary application, which makes it appropriate for research (Melnikovas, 2018). Therefore, this framework was selected for this study to design the data collection methodology. The complete information regarding the stages of the research onion and the approaches selected for this study in each stage are discussed below:

4.2.1 Research Philosophy

It is a collection of assumptions about how knowledge grows (Saunders and Lewis, 2018). According to (Rehman & Alharthi, 2016), a research philosophy or paradigm is 'the fundamental belief system or global perspective that guides the investigator. Consequently, it develops a proposition to support a position on how research should be carried Interpretivism, pragmatism, and positivism (Saunders and Lewis, 2018). are three research philosophies. A brief discussion of them can be seen in Table 4.2 below.

Table 4-2 The brief discussion of research philosophies

Research Philosophies	Description
Positivism	This assumes that the future may be predicted and controlled. Future predictions are based on our knowledge of the present and past; discovering event patterns based on deterministic, law-like, and functional relationships allows for accurate forecasting of future events (Melnikovas, 2018).
Interpretivism	This paradigm implies that the future is unknowable. Because the future is regarded as a random, uncontrolled, and unexpected series of occurrences, it is difficult to control or forecast it (Melnikovas, 2018). Knowledge of the future can only be gained by intuitive strategy.
Pragmatism	This paradigm is founded on the idea that investigators should utilize the philosophical and methodological approach that is most appropriate for the research subject at hand (Kaushik & Walsh, 2019). In other words, it entails research designs that include operational judgments based on what will work

	best in determining answers to the topics under inquiry, allowing pragmatic researchers to conduct research in novel and dynamic ways to solve research challenges (Kelly & Cordeiro, 2020).

The ***pragmatism research philosophy*** was chosen as the research philosophy for this thesis. It was chosen because it aims to determine what works and facilitates problem-solving solutions (Prasad, 2021). Furthermore, it was chosen since this style of study philosophy aims to make human problem-solving easier by examining it from several perspectives (Kaushik & Walsh, 2019). This form of research philosophy allows scientists to establish their philosophical paradigm by using research methodologies based on theory, methodology, and change choices (Parvaiz et al., 2016). It also involves numerous assumptions regarding the world's perspective. These hypotheses support the type of research plan required and the method chosen as part of the strategy. Real-life events may influence the researcher's research philosophy, but the most significant impact is their perception of the relationship between procedure and knowledge (Saunders et al., 2019). It allows the researcher to choose the methods, strategies, and procedures for the study most suited to their research goals and a thorough comprehension of the issue statement (Kelly & Cordeiro, 2020). It is a problem-solving strategy that believes the best research methods allow a researcher to respond appropriately to the questions given in a specific study (Kaushik & Walsh, 2019). In social science, this method combines quantitative and qualitative methodologies to analyze various issues raised in the study ((M Saunders & Lewis, 2018). This is done to make research more useful regarding expected outcomes and consequences.

4.2.2 Research Approach

Inductive and deductive research methodologies are the two types of research approaches to developing theories. A brief discussion of them can be seen in table 4.3 below:

Table 4-3 A brief discussion of research approaches

Research approaches	Description
Inductive research	It entails looking for patterns in observations and formulating explanations for theories using a sequence of hypotheses (Azungah, 2018). The key objective of the inductive technique is to free research findings from the constraints imposed by organized methodologies, allowing them to arise from the

	common, dominant, or noteworthy patterns present in raw data (Woiceshyn & Daellenbach, 2018).
Deductive research	"Developing a hypothesis (or hypotheses) using existing theory, and then constructing a research method to test the hypothesis" is what a deductive approach is all about (M Saunders & Lewis, 2018)." Deductive reasoning" is defined as "reasoning from the particular to the universal (Azungah, 2018)." If a case or a theory example implies a causal relationship or link, it may be accurate in many circumstances. A deductive design may be used to check if this relationship or link holds true under more broad conditions (Azungah, 2018).

Notably, the ***deductive research method*** is used in this thesis. It was chosen because it helps the investigator explore theories and models related to the subject matter being reviewed (Woiceshyn & Daellenbach, 2018). A conceptual framework is developed using this method's existing theory (M Saunders & Lewis, 2018). It can also help with the comprehension of causal links between concepts and variables, as well as quantifying notions. It can also be used to generalize study findings to some extent.

4.2.3 Research choice

Mono-methods, Mixed-Methodologies, and Multimethod are the key examples of research methodologies. A brief discussion of the choice of research methods can be seen in Table 4.4 below:

Table 4-4 A brief discussion of the choice of research methods

Research Methods	Description
Mono-Method Research	This type of research entails employing only one method to conduct a study (either one quantitative method or one qualitative method) (Ojebode, Ojebuyi, Oladapo, & Oyedele, 2018). The qualitative research method analyses individual perspectives of natural events by interpreting non-numerical data (Ahmed & Sobuz, 2019). In contrast, the quantitative approach concentrates on measuring numerical data and some methodological principles to understand their relationship (Apuke, 2017).
Multimethod	Multimethod research is defined as a study that incorporates various types of qualitative data (such as interviews and observations) as well as multiple types of quantitative data (such as experimental data and survey data) (Creswell, 2014).
Mixed-Methodologies	This method combines qualitative and quantitative research methodologies. The data collection approach proposed is a mixed method.

	It is a research design incorporating qualitative and quantitative research approaches (Mondal, Mondal, & Shibpur, 2018). A mixed methodology research approach entails collecting, assessing, and combining quantitative (surveys, experiments) and qualitative (interviews and focus groups) data (Dawadi, Shrestha, & Giri, 2021).

The ***mono method*** was chosen for this project as the data collection method. The mono method involves using only one approach (either quantitative or qualitative method) (Odediran & Windapo, 2017) for a given study. It will be done using a qualitative method (secondary study and interview). ***The qualitative method*** was chosen because it includes a comprehensive description of the participants' feelings, ideas, and encounters and interprets the implications of their actions (Ahmed & Sobuz, 2019). Meanwhile, secondary research was selected because it enables researchers to draw new conclusions from prior research. The interview was chosen because it enables the interview to assess the participant's spontaneity (Abidin, 2010).

4.2.4 Research Strategy

This section covers the plan of action designed to achieve the research objectives using a systematic approach. The survey, phenomenology, grounded theory, case study, action research, experiment, and ethnography are examples of research methodologies (Melnikovas, 2018).

Table 4-5 Research Methodologies

Ground theory	focuses on developing a theory that is 'grounded' in data that has been obtained and analyzed systematically (Chun Tie, Birks, & Francis, 2019). It is used to discover social links and collective behaviours, referred to as social processes. The goal of grounded theory is to uncover or develop a theory from data that has been collected consistently and analyzed through comparative analysis (Bryant & Charmaz, 2019). Grounded theory is a complicated methodology that is fundamentally flexible. As a result, new scholars attempt to comprehend the discourse surrounding grounded theory concepts and processes and the practical application of grounded theory concepts and processes (Chun Tie et al., 2019).
Action research	a method for delving into topics and solving issues people face daily. Although it is most commonly linked with educational research, action research is used in various fields (Brown & Coombe, 2015); (Erro-Garcés & Alfaro-Tanco, 2020). Action research is a catch-all word for various methodologies from many research traditions. Academics and educators have diverse views on what it is, what it is for, and who can conduct it (Lufungulo, Mambwe, & Kalinde, 2021).

A case study	a comprehensive investigation into a current occurrence's natural surroundings (Sammut-Bonnici and McGee, 2015). Furthermore, it is defined as "an intense study of a person, a group of persons, or a unit to generalize over several units (Heale and Twycross, 2017). A case study is also an extensive, systematic analysis of a single individual, group, community, or other units in which the researcher investigates in-depth data relating to multiple factors (Heale and Twycross, 2022).
Experimental research	a scientific research strategy (Cash, Stanković, & Štorga, 2016). It consists of a hypothesis, a researcher-controllable variable, and variables that may be calculated, measured, and analyzed. Above all, experimental research is conducted in a controlled setting (Mitchell, 2015). The investigator gathers the data, and the outcomes will support or refute the hypothesis.
Ethnography	this is concerned with finding and describing a group's or individual's culture (Sharma, 2017). It is a qualitative methodology for studying tiny societies' beliefs, social relationships, and behaviours (Black et al., 2021). It entails participation and observation over time, as well as interpreting the data gathered.

The research Question of this research is how to improve lean construction implementation from the Human Capital perspective. Lean construction was created to address problems in the construction sector (Koskela, 1992). It has a proven track record of being a powerful facilitator for integrating construction operations and supply chain management successfully (Dallasega et al., 2021). Therefore, this research did not aim to develop any theory and the grounded theory is not appropriate. Also, the research is not about ‘what is it ‘with the involvement of the day today operation, and Action research was not an option. ***The case study*** strategy was selected for this research because to develop a framework for lean construction implementation, a specific group from the construction industry needs to be approached to answer the research question. According to Heale and Twycross (2017), a case study is an extensive, systematic analysis of a single individual, group, community, or other units in which the researcher investigates in-depth data relating to multiple factors (Heale and Twycross, 2022).

4.2.5 Research Time Horizon

The primary data collection approach proposed is qualitative. A time horizon (also called a planning horizon) is a period in the future during which particular procedures are evaluated or assumed to be completed (Melnikovas, 2018). According to the research onion, time horizons can be classified as cross-sectional or longitudinal. A brief discussion of the types of time horizons can be seen in Table 4.6 below.

Table 4-6 A brief discussion of the types of time horizon

Time Horizon	Description
Longitudinal studies	They use continuous or recurring assessments to track specific people over long periods, often years or decades. They are usually observational, with quantitative and qualitative data collected on any blend of events and outcomes, with no outside influences applied (Caruana et al., 2022).
A cross-sectional study	This refers to an observational study design in which the investigator simultaneously measures the result and the study participants' exposures (Setia (Setia, 2016). As a result, a particular quick glimpse at the findings and the associated features at a certain time. Cross-sectional studies are commonly used to estimate the frequency of an outcome of interest in a given community to plan public health interventions (Kesmodel, 2018). It summarizes the result and its attributes at a specific time or over time (X. Wang & Cheng, 2020).

Cross-sectional studies represent the time horizon used in this thesis. This thesis chose a cross-sectional design because it covers a specific period, saves time, and can confirm or refute hypotheses (X. Wang & Cheng, 2020). Furthermore, the data can be used in various investigations, and numerous findings can be evaluated to develop a more in-depth study or new hypotheses (Setia, 2016). Moreover, they are typically fast, simple, and inexpensive to conduct (Sedgwick, 2014a).

4.3 Research Techniques and Process

This layer, as the last layer of the Research Onion framework, represents Data Collection and Data Analysis. According to Nahum (2007), the techniques adopted for the conduct of an investigation depending on the nature of the investigation and the type of data and information necessary and available.

4.3.1 Interviews

There are several types of techniques, such as questionnaires, interviews, observations, and checklists. Surveys are typically the most extensively utilized research (van Meerkerk et al., 2019). (Vaske, 2019) defines a survey as a research approach that can be used to execute a non-experimental descriptive design to explain an unavoidable reality. A survey-based questionnaire is typically limited to a representative sample of a population with research interests (Young,

2015). Additionally, the survey method can be used to gauge popular opinion based on the characteristics of several persons using questionnaires and sample methodologies (Ponto, 2015).

On the other hand, phenomenology as a philosophy offers investigators a theoretical framework for comprehending occurrences in subjective reality. Thus, this philosophical framework, or theory of subjective reality, is likely to play a significant role in comprehending the actor or subject in relation to a specific event or phenomenon in their life (Qutoshi, 2018). In a phenomenological method of inquiry, the researcher might use observations, interviews, and conversations as data-collecting tools. As a result, phenomenology has both philosophical and methodological orientations. To do so, one must first comprehend it from a historical and philosophical perspective. The key research question of this research is how to improve lean construction implementation from Human Capital perspective. To answer this question, open questions need to be asked from the group of professionals selected from the construction industry. Therefore, the most suitable research technique is interviews.

The interview is an effective data collection approach that involves the researcher and the subject communicating verbally (Alshenqeeti, 2014). The interviewer manages the interaction and asks questions while the interviewee responds to the questions. Interviews can be conducted online, in person or over the phone. The internet is also becoming more popular as a tool for conducting interviews. In exploratory and descriptive investigations, interviews are frequently used (Truong, 2021). As a result, interviews are best suited for complex circumstances when visual demonstrations are necessary and immediate feedback is desired (Qu & Dumay, 2011). Moreover, the interview method provides advantages such as a high response rate, the usefulness of gathering in-depth and supplementary information, and the opportunity to explain questions/further clarifications (Alshenqeeti, 2014). The interview method is best suited where:

- Qualitative data is needed to validate certain measures or illustrate and clarify the significance of the findings after the quantitative investigation is completed (Alamri, 2019).
- it is mandatory to conduct exploratory work before carrying out a quantitative study (Bolderston, 2012),
- Individual historical descriptions of how a certain occurrence arose are necessary (Jamshed, 2014),
- Individual perspectives of social processes will be investigated prospectively through a series of interviews (Stuckey, 2013),

- A study focuses on the participants' interpretations of specific phenomena (Jamshed (Jamshed, 2014).

Interviews can be classified into three forms: structured, semi-structured, and unstructured interviews (Adams, 2015).

Table 4-7 Forms of interviews

Unstructured interview	Here, the interviewer does not enter the interview setting with a planned sequence of questions to be asked of the respondent. The primary purpose of the unstructured interview is to bring out some preliminary issues to the respondents and probe into several factors in the situation that might be central to the broad problem area. This helps the researcher to determine variables/issues that may need further investigation (Murphy & Keeping, 2018). However, unstructured interviews provide in-depth information, which may be difficult to analyze compared to structured interview information (Adams, 2015).
Semi-structured interviews	These allow flexibility for the interviewer to use the opportunities offered to enrich the data: the interviewer can formulate questions while carrying out the interview (Ruslin, Mashuri, Rasak, Alhabsyi, & Syam, 2022). In addition, they enable the use of a theoretically informed interview Pro-forma to build structure into the data collection process (DeJonckheere & Vaughn, 2019). Semi-structured interviews are more formal than unstructured interviews because the interview is built around many defined subjects (Jamshed, 2014). Thus, all participants receive some questions in common.
Structured interview	This seeks high levels of reliability and repeatability (Rashidi, Begum, Mokhtar, & Pereira, 2014). Thus, the same question set was used for every respondent in the same manner. Therefore, structured interviews provide uniform information, allowing comparisons (Doll, 2018). In most instances, the findings of structured interviews allow the researcher to describe or quantify certain phenomena, identify a specific problem, and evolve a theory of the factors that influence the problem or find answers to research questions (Rashidi et al., 2014). In a structured interview, the interviewer asks predetermined questions as specified in the interview schedule.

This thesis will use the semi-structured interview method. It was chosen because it is useful for conducting in-depth interviews (Kakilla, 2021). This is because, during the semi-structured interview, the researcher can typically critically examine the conversations and varied first superficial responses to arrive at complex findings (Brown, 2019). Most of the time, an investigator can follow up since all verbal and non-verbal replies, such as hunches, laughter, and silence, provide information that can be useful in the final data analysis of the conversation's various topics (Barbour, 2018). To achieve flexibility, the interviewer synthesis many themes (Ok

Jong and Kwan Jung, 2015). An investigator can explore multiple topics with several themes in a semi-structured interview. Furthermore, the semi-structured interview's participatory aspect allows the participants to respond freely (DeJonckheere & Vaughn, 2019). In addition, computer-aided qualitative data analysis on well-coded themes using flexible coding can give reliable results from huge interview samples (Deterding & Waters, 2021). The dynamic aspect of the Semi-Structured Interview increases the possibility of implementing new ideas. Facts on themes are recorded in their natural forms during semi-structured interviews. When both sides (interviewer and interviewee) actively participate in the interview, a well-presented semi-structured interview can effectively draw forth the interviewee's inner voice.

4.3.2 Sampling approach

Sampling is widely employed in research since obtaining data from a large study population is impractical. Choosing samples from a large population for specific research reasons is known as sampling design (Kabir, 2016). Simple random sampling, non-probability sampling, systematic sampling, stratified sampling, probability sampling, cluster sampling approach, and others are examples of sampling methods. A brief discussion on these methods is presented in Table 4-8 below.

Table 4-8 Sampling approaches

Simple random sampling:	Any element and combination of elements in the population have an equal chance of being chosen as a sample member in this sampling method (Bhardwaj, 2019). This method is a reasonable way of choosing a sample because it is among the most basic forms of random sampling (Etikan & Bala, 2017). Simple random sampling is the most well-known probability sample since each member of the population has an equal chance of being selected.
Non-probability sampling:	The sample is drawn using non-randomized procedures in a non-probability sampling methodology. The majority of non-probability sampling methods entail judgment (Etikan & Bala, 2017). Rather than randomization, individuals are chosen based on their accessibility.
Systematic sampling:	Systematic sampling is a form of probability sampling approach in which individuals of a more significant population are randomly chosen from a larger population but at a fixed, periodic interval (Mostafa, Picazo Rubio, Brailovski, Jahazi, & Medraj, 2017). The desired sample is used to divide the population size to calculate the sampling interval. A systematic sample is achieved by taking a random start towards the top of the population list and evenly spacing each unit

	subsequently (Taherdoost, 2016). Systematic sampling techniques with probability proportional to an auxiliary variable can be included. Compared to alternative sample systems, systematic sampling is quantitatively efficient in many instances. This is especially the case in populations with linear and quadratic trends, as well as populations that are autocorrelated.
Stratified sampling:	The sample members are separated into strata based on specific criteria (Iliyasu & Etikan, 2021). A predefined number of units is drawn randomly from these smaller homogeneous groupings. Proportionate and disproportionate stratified random samples are the two types of stratified random sampling (Iliyasu & Etikan, 2021). Proportionate stratified sampling occurs when the sample size is proportional to the size of the unit (Parsons, Maclaran, & Chatzidakis, 2017). In contrast, disproportionate stratified sampling occurs when the number of samples is not proportional to the size of the unit (Eyisi, 2016). Personal judgment and convenience are two factors that influence disproportionate stratified sampling (Taherdoost, 2016).
Probability sampling:	Probability sampling is a sampling approach in which an investigator uses a method based on probability theory to select samples from a larger population (Uprichard, 2013).
Cluster sampling approach:	Cluster sampling is a technique in which investigators divide a population into smaller groups called clusters (Taherdoost, 2016). They then build a sample by selecting clusters at random. Cluster sampling is a probability sampling approach that is frequently used to research large populations, especially geographically distributed ones (Sedgwick, 2014).
Snowball sampling:	Snowball sampling allows the researcher to reach populations that are difficult to sample when using random sampling methods. The process is cheap, simple and cost-efficient because snowball sampling relies the participants to recommend others Atkinson and Flint (2001).

Notably, ***a simple random sampling method and snowball method*** were used to invite the participants for the semi-structured interviews. Selecting a study sample from a given population is known as simple random sampling (Bhardwaj, 2019). Due to its unbiased nature in obtaining responses from a wide population size, this strategy was chosen for the study (Taherdoost, 2016). It also assures that each participant in the population has an equal chance of being selected, as (Sharma, 2017) pointed out. It is also a reliable sampling technique that accurately represents the target population. However, depending on the availability of the professionals, the snowballing technique was used to invite more participants.

4.3.3 Data Analysis

The process of evaluating, cleaning, manipulating, and modelling data to identify usable information, influence judgments, and assist decision-making is known as data analysis (Kudyba & Kudyba, 2014). Data analysis comprises many key aspects and methodologies, including a wide range of techniques under various names and being used in various business, science, and social science domains (Pruneau, 2017). Generally, non-numerical data is referred to as qualitative data (Ahmad, 2017). The most familiar qualitative data analysis methods include qualitative content analysis, narrative analysis, discourse analysis, thematic analysis, grounded theory, and interpretative phenomenological analysis. They are briefly discussed in table 4.9 below.

Table 4-9 Data Analysis Methods

Qualitative Content Analysis	The most popular and simplest qualitative data analysis method is content analysis (Elo et al., 2014). At its most basic level, content analysis is used to examine patterns within a piece of information, including phrases, words, or images or across several content or communication sources (Elo et al., 2014). It can determine how a concept is shared or discussed (Roller, 2019). Alternatively, it could be used to look for trends in more profound underlying interpretations. The possibility of applying content analysis in so many different ways makes it critical to start with an exact question and purpose, or the researcher may become lost in the haze (Kleinheksel, Rockich-Winston, Tawfik, & Wyatt, 2020). Large volumes of text are sorted into codes and then summarised into categories using content analysis (Kleinheksel et al., 2020). Furthermore, the data might be summarised to determine the prevalence of specific concepts or variables (Lindgren, Lundman, & Graneheim, 2020). As a result, the content analysis incorporates a dash of quantitative thinking into a qualitative process (Mayring, 2014).
Narrative Analysis:	As the name implies, narrative analysis entails listening to individuals tell tales and analysing what they signify (Allen, 2017). It could depict how people handle and understand reality by analysing their stories and how they are delivered because stories have a functional purpose of helping us comprehend the world (Figgou & Pavlopoulos, 2015). Narrative analysis can also be used to determine whether the manner in which something is said is significant (Edwards, 2016).
Discourse Analysis:	The discourse analysis aims to examine language in its social context. In other words, it focuses on analysing language – such as a conversation, a speech, and so on – in the context of the culture and society in which it occurs (Manzoor, Saeed, & Panhwar, 2019). Notably, the culture and history of those involved in the communication are critical to fully comprehending these talks or speeches. As a result, discourse analysis can reveal how culture, history, and power dynamics influence how concepts are discussed. Thus, discourse analysis might be useful if the research goal is to understand a culture or power dynamics (Song, 2010). Since there are so many social impacts on how we communicate

	with one another, discourse analysis has much potential. Of course, this implies that it is expedient to have a very clear research topic (or questions) while analysing data and looking for patterns and themes.
Thematic Analysis:	This is a technique for methodically identifying, organising, and interpreting patterns of meaning (themes) in a dataset. It enables the investigator to recognise and comprehend common or collective meanings and experiences (Braun & Clarke, 2012). It strongly emphasises data organisation and description, as well as improving the theoretical understanding of data trends. This analysis entails more than simply counting the number of words in a text (Alhojailan, 2012). It aids in investigating the data set's precise and intrinsic meaning (Braun & Clarke, 2012). It is usually used to describe a collection of interview transcripts (Braun & Clarke, 2012). Coding is an essential step that aids in developing themes by recognising aspects of analytical relevance within a data collection and labelling them (Boyatzis, 1998). The process of coding involves assigning data to predetermined topics. Thematic analysis is unique in its relatively versatile theory postulation, research questions, and design. This style of analysis is used to look into the respondent's life experiences, his ideas and attitudes about activities, and the social procedures that influence and shape a certain notion (Nowell, Norris, White, & Moules, 2017). It also comprises the obvious and inherent principles that shape a technique, as well as the social construct of meaning and the portrayal of a social picture in a text or setting (Salleh, Ali, Yusof, & Jamaluddin, 2017). Face-to-face interviews, secondary sources, surveys, focus groups, field research, observation, and a variety of other methods are used to analyse practically all types of qualitative data (Liamputtong, 2020). Open-ended survey questions, short responses and many pages of interview papers could all be included in any data collection (Kabir, 2016). It can also be used to analyse data sets of any size. Because of its theoretical flexibility, it is also used in mixed-method research (Imran & Yusoff, 2015). It provides the opportunity to make a direct choice over procedures based on specific theoretical assumptions (Kiger & Varpio, 2020).

Notably, the data obtained through interviews were analysed using a ***thematic analysis technique***. It was chosen because it is a systematic, replicable technique for compressing many text words into fewer content categories based on explicit coding rules (Maschi & Drisko, 2015). NVivo 11 software is used to identify; a) the barriers to implementing Lean Construction,b) the link between human behaviour and lean implementation, and c) the strategies to implement Lean Construction from a behavioural perspective through a content analysis after the transcription of the interviews (Zamawe, 2015).

4.3.4 Data Triangulation

This thesis aims to develop a framework for improving the construction process flow by implementing lean construction from the Human Capital perspective. The research approach is qualitative with the feature of subjectivity. A qualitative researcher seeks to define and interpret unclear phenomena through non-numerical methods of measurement that focus on meaning and insight (Aspers & Corte, 2019). Moreover, in qualitative research, researchers accept that they cannot separate themselves from the research by bringing their personal experiences, values, and perspectives (Jackson, 1990). However, according to (Fusch, Fusch, & Ness, 2018), a saturation of multiple qualitative data sources can be achieved through triangulation. Data triangulation adds depth to the collected data. Each data point represents different data of the same event, discovering commonalities within dissimilar settings. Furthermore, the data points take place over time to observe ongoing interactions—days, weeks, months, and years.

Data triangulation of this thesis occurs by converging information from different sources, as stated below.

- A conceptual framework was developed through literature.
- A guideline for semi-structured interviews was designed to answer the research question.
- A guideline was designed for semi-structured interviews for experts.
- A framework was developed compared to the conceptual framework.
- The developed framework was refined and validated with expert opinions.

4.3.5 Validity and Reliability

A fundamental concern in qualitative research is the degree of confidence a researcher can place in what the researcher had been seen or heard (Austin & Sutton, 2014). Therefore, the concept of validity and reliability are vital in qualitative research. According to (R. K. Yin, 2003) there are four tests in qualitative research as below.

Construct validity establishes the operational measures (Gibbert, Ruigrok, & Wicki, 2008) by establishing a clear chain of evidence and data triangulation (Yin, 2003). A detailed account of the data collection process is provided in the following sections that inform the case selection criteria (which is primarily based on Table 1) and the multiple data collection techniques used. It further

explains the procedure followed to access the case firms and the ethical considerations. Also, the key question that needs to be addressed is whether the data collection instrumentations were appropriate. The construct validity for this research will be established using an appropriate interview design with semi-structured questions (see Appendix A.4). The semi-structured interview questions enable to make an in-depth inquiry regarding the phenomenon.

Internal validity refers to establishing a causal relationship whereby certain conditions are shown to lead to other conditions. In other words, it refers to the causal relationships between the variables and the results (Gibbert et al., 2008). The empirical work is based on a framework founded on existing literature and theoretical perspectives that enables the data to be scoped and kept relevant. The coding process enables pattern identification (Creswell, 2014). Finally, these patterns and other findings are triangulated with theory and the framework for interpretation (Yin, 2003).

The researcher must demonstrate that the analytical strategies are applied, and the suggestions are linked to the data in this situation. This thesis developed a conceptual framework through a systematic literature review; this conceptual framework was mapped with the data obtained through in-depth interviews.

External validity ensures analytical generalisability (Eisenhardt, 1989; Rowley,2002; Yin, 2003). In a qualitative analysis process, data are a co-construction of meaning between the participants – usually the practitioners– and the researcher (Gibbert et al., 2008). External validity establishes how a study's findings can be generalized. This can be achieved by establishing an appropriate unit of analysis and sampling strategies. The unit of analysis of this thesis is identified as the "construction professional" in the construction industry, and purposive sampling was carried out to generalize the findings. Purposive sampling, also characterized as selective, judgemental, or subjective sampling, is a type of non-probability sampling in which investigators choose people from the population to partake in their surveys based on their judgment (Etikan, 2016). It assists the research in getting the most out of a limited target population and producing useful research results. Purposive sampling helps the researcher to collect qualitative replies, resulting in more precise study results and better insights (Sharma, 2017).

Reliability means that the operations of a study can be repeated with the same results. Hence, it requires being transparent about the methodology and achieving consistency across the unit of analysis (Taherdoost, 2016). (Cao et al., 2021) noted three ways of assessing reliability: test re-test, internal consistency, and alternative form. Additionally, comparing the data collected with other data from various sources is also a way of ensuring reliability (Saunders et al., 2007). The interview guideline was prepared to capture the data around the research question in this thesis. Also, the same interview guideline was used for all participants. Thus, it ensured consistency across the unit of analysis.

4.3.6 Ethical, Legal and Social Issues

As with any field-based research, this thesis had to consider ethical concerns due to the nature of the study (Denzin & Lincoln, 1998). Prior to commencing the empirical phase of the research, this thesis sought and received approval from the Ethics Committee of Auckland University of Technology. The main ethical concerns were the confidentiality of the firms and individuals that would be part of the study. Concerns also included the use of digital recordings in interviews and the participants' right to refuse to record or be removed from participation altogether, even if consent was given earlier. A description of the study, and protocols and procedures that would be followed, were given to the firms and individual participants before gaining formal consent allowing sufficient time for clarifications and discussions. Formal consent forms outlined their right to remove from participation at any stage, refuse audio records, and refrain from participating in observed events. These concerns were revisited prior to interviews and observations to ensure that participation is both voluntary and through informed consent. Transcripts of interviews were provided to participants who requested them. Furthermore, the study uses a coded process to refer to the firms and the participants to ensure anonymity. Even though the details of the firm and participant profiles are actual, the names used are codified to prevent identification. The ethical approval received for the interview and the expert opinion are attached in Appendix A.

4.4 Summary of the Research Design

This section of the thesis detailed the tools and strategies used to achieve the study on 'how to improve the Lean Construction Implementation from the Human Capital perspective.' It used the research onion. As a result, it provided a detailed discussion of the steps of the research onion. It discussed the appropriate methods for each step. Importantly, it highlighted the chosen methods and provided the underpinned rationale behind the selection. The research onion layers were explained in the above sections with the choices for this study, including the rationale. Table 4.6 demonstrates the choice of the research design for each layer of the research onion.

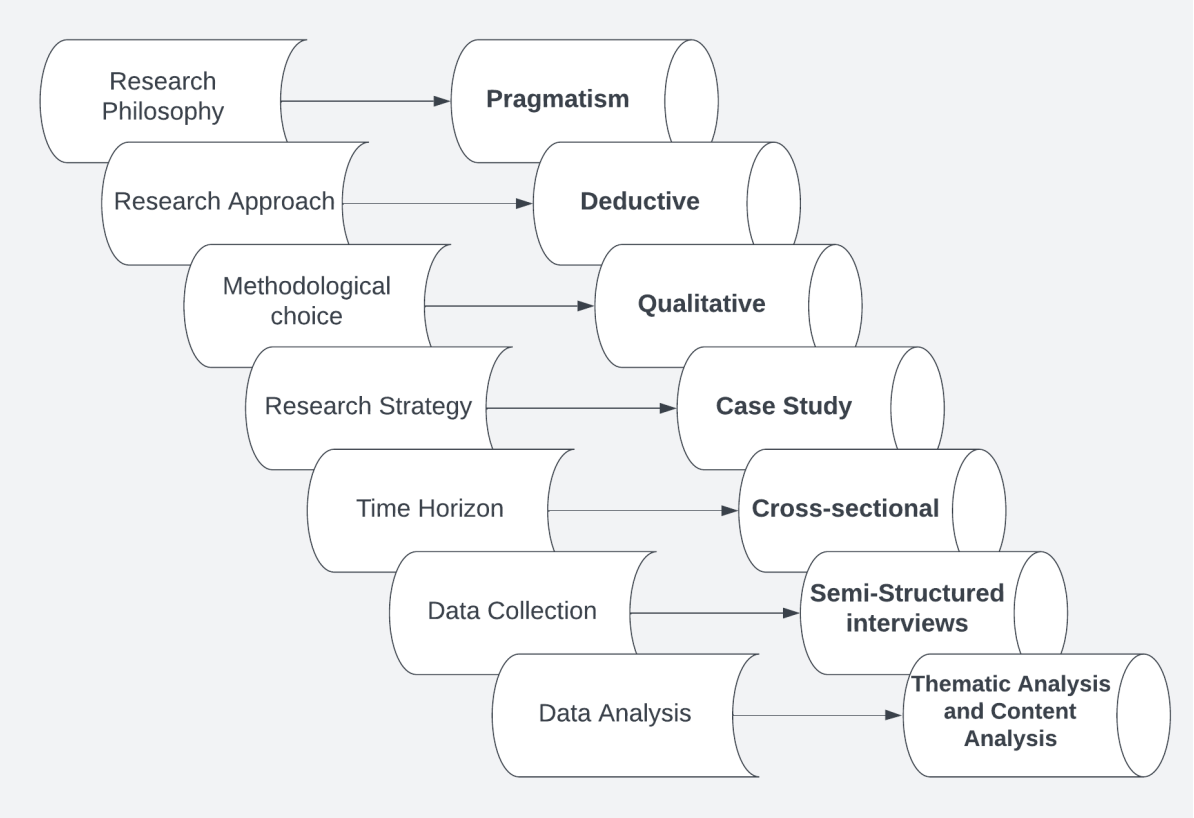

Figure 4-3 Summary of the research design based on the framework developed by Saunders and Lewis, 2018

Next, the research methodology carried out for the research is described under the heading of Research Methodology.

4.5 Research Methodology

This chapter mainly covers two sections: research design and research methodology. In the above section research design is discussed, and the below section presents the details of the research methodology adopted for this research.

4.5.1 Research procedure

This section presents the methodology carried out in the research to achieve the aim and objectives by answering the Research Question. Figure 4,4 demonstrates how these aims and objectives were achieved by answering all the research questions. There are five steps followed to collect the data using both secondary and primary data. These are.

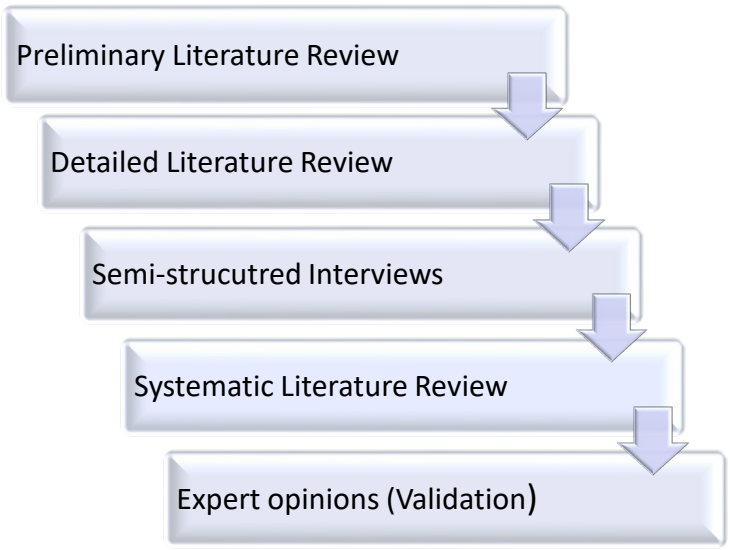

Figure 4-4 Research methodology process

The aim of the research is to develop a framework for improving the Lean Construction Implementation from Human Capital perspective. There were four objectives to achieve this objective. First, the research gap was identified as the Lean Construction Implementation is slow due to many barriers with the preliminary literature review and then the research question was formulated as “How to improve Lean Construction Implementation from Human Capital perspective. The below figure 4.5 shows the research process followed to achieve the aim of this research.

This Flow chart shows the aim and objectives of the research in the left side of the figure, the middle section shows the research question and the sub-research questions. The right side of the figure demonstrates the problem statement of the research and how the secondary and primary data were collected using different techniques.

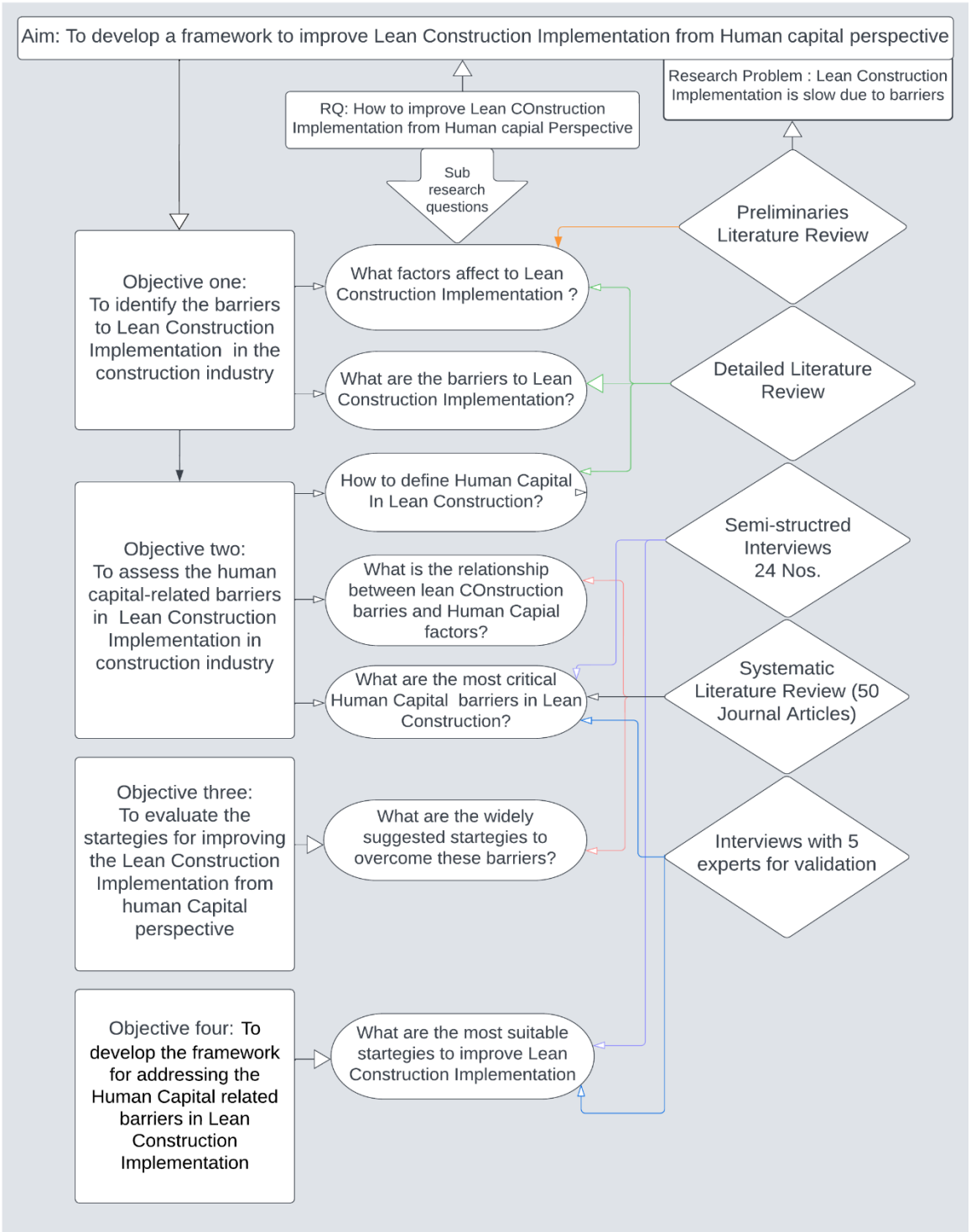

Figure 4-5 Research methodology flowchart

4.5.2 Secondary data collection process

A secondary study entails collecting, describing, and analyzing what has already been published on a given topic (Ramdhani, Ramdhani, & Amin, 2014). It is usually included as part of a research thesis, although it can also be used as a stand-alone review of relevant materials. It can be as simple as a list of sources, but it typically follows a structure and includes a summary and synthesis. A secondary study aims to build on and critically evaluate past research in a systematic, detailed, and analytical manner. Its primary goal is to present a thorough picture of what is known about a particular issue.

Secondary studies are of various types, including narrative literature review, systematic literature review, scoping literature review, argumentative literature review, integrative literature review, and theoretical literature review, among others (van der Waldt, 2021). The approach that was taken to achieve the second study is in three stages which are preliminary literature review, detailed literature review and systematic literature review, as indicated in Figure 4-6 below.

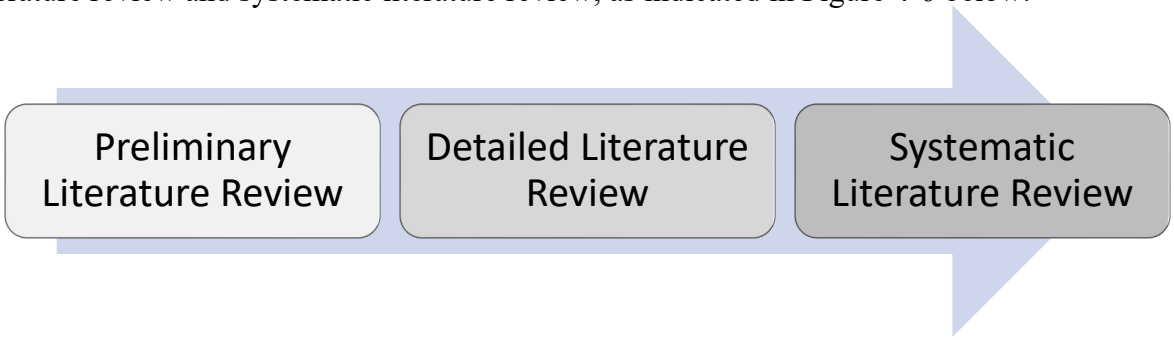

Figure 4-6 Stages of the secondary study

The preliminary literature survey was carried out to explore the research background, define the research problem, and understand the reasons for the low implementation of lean Construction in Construction projects. A preliminary literature review revealed several barriers to implementing lean construction, most of which are related to Human Capital. The research proposal was formulated based on this preliminary literature review. The systematic literature review was majorly used to finalize the secondary research of this thesis. A systematic review is an exhaustive literature review that differs from a formal literature review in that it is conducted methodically (Boland et al., 2017). It is carried out methodically or consistently, according to a set process, to eliminate bias and consolidate the gathered data (Jahan, Naveed, Zeshan, & Tahir, 2016). It also helps address specific research questions and tests some hypotheses by providing a keener

assessment of original data (Tawfik et al., 2019). The steps involved in carrying out a systematic review based on Pollock and Berge (2017) were as figure 4-7 below.

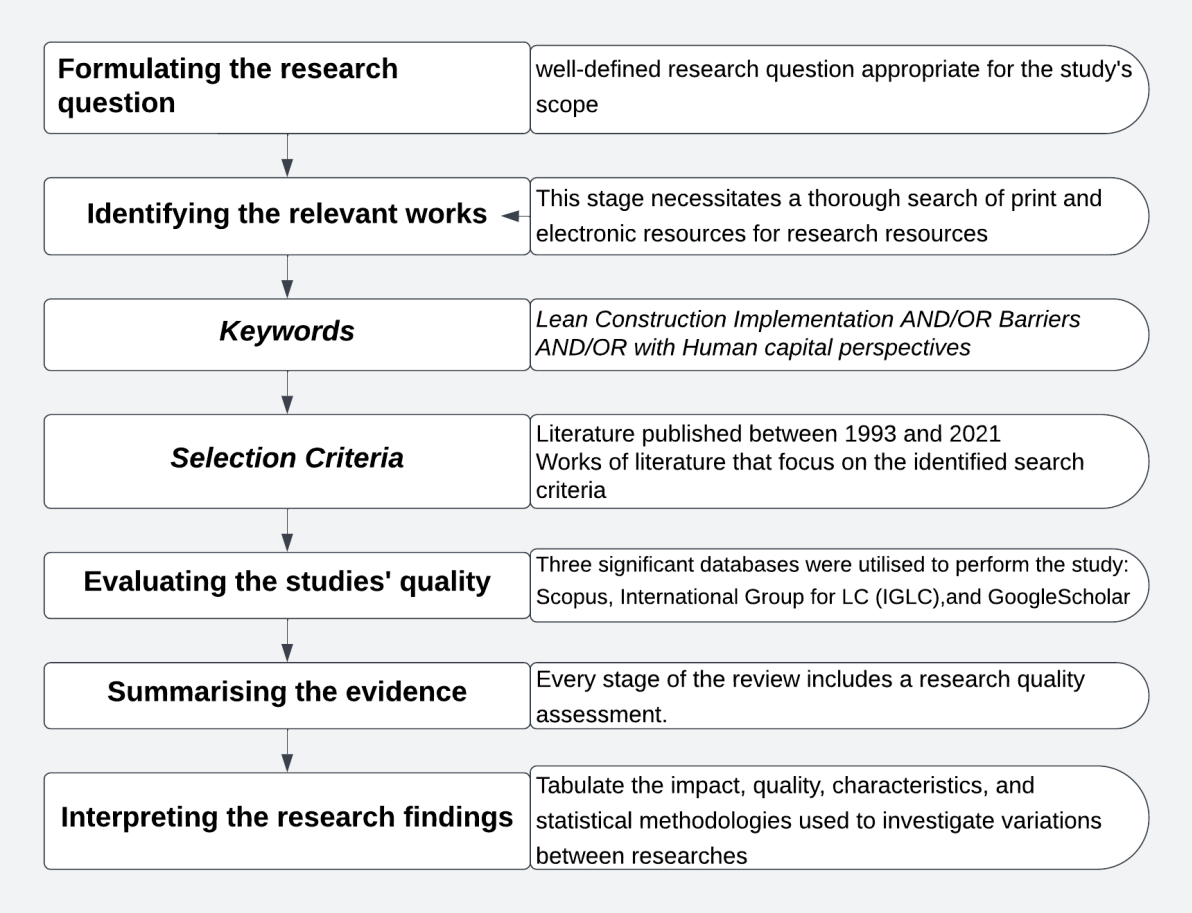

Figure 4-7 Steps in the systematic literature review

The primary study was conducted using interview responses and expert opinions and the next section presents details of the primary data collection.

4.5.3 Primary Data Collection

Semi-structured interviews

The questions used for the interview are provided in Appendix A.4. All the interviews were online using the Zoom app or Skype. However, face-to-face interviews were conducted either in a public place or the participant's organization, based on the participants' preferences. The researcher sent the eligible participants a formal invitation via their personal or official email. The invitation was sent one month before commencing the interview to allow the participants to consider the

invitation. They consented by agreeing to participate in the research and signing the consent form. They did this before the interview commenced. When the participants were identified, their profiles were viewed. After two weeks of the invitation, a follow-up email was sent. If there was no response to the second email, the researcher sought another eligible participant.

The primary researcher was working with the participants with mutual respect. The participants were construction professionals who would benefit from this thesis during the interviews and after the study is completed. The participants' contributions were also acknowledged in the thesis and any resulting publications. Confidentiality was maintained, and participant identity will be concealed. This was done to adhere to ethical conduct regarding surveys and interviews. Maintaining their confidentiality and concealing participants' identities was achieved by not documenting them to avoid their misuse or leakage. The proposed consent form is in Appendix A.3.

Expert Opinions

An expert opinion is a judgment made by a person with superior expertise in a certain domain to solve a problem (Souto, 2013). As a result, the phrase encompasses domain specialization and knowledge superiority, referred to as expertise (Bhandari & Hallowell, 2021). Both are required to be able to provide competent advice. This method was chosen because it aids in establishing a case and defining genuine concerns, as it employs the strict application of scientific research procedures and enables a high-quality scientific survey of experts (Hohmann, Brand, Rossi, & Lubowitz, 2018).

A total of twelve experts who have experience in lean construction implementation for more than ten years were invited due to the time constraints to achieve this thesis. However, only five were interviewed to refine the developed framework. The questions were asked about the strengths and weaknesses of the framework; the improvements suggested were accommodated into the framework.

The below figure 4-8 shows the details of the experts in lean Construction Implementation in New Zealand.

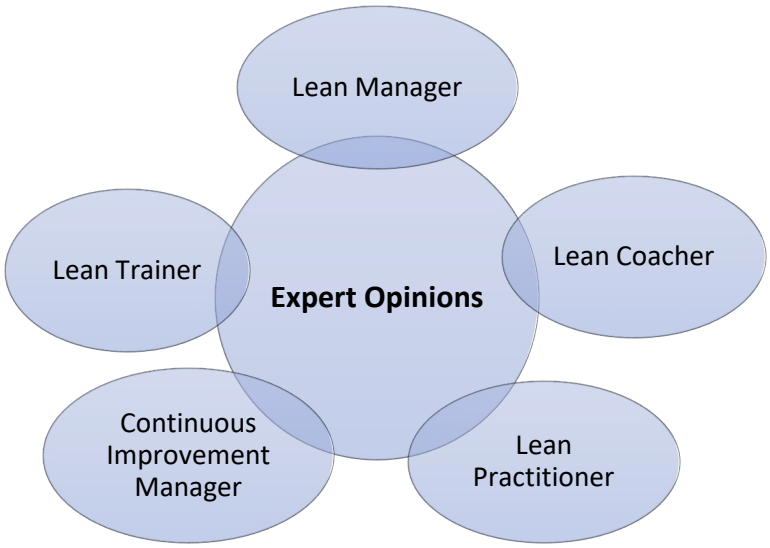

Figure 4-8 Expert opinion participants for validation

Participant Selection

Concerning participant selection, the following sections were discussed:

Study population: A study population is the general public from whom the researcher seeks to obtain specific information or experience (Palinkas et al., 2015). It refers to the complete range of items and subjects that can be studied to fit particular requirements (Majid, 2018). Accordingly, the participants are construction professionals in the construction industry from various categories, such as Quantity Surveyors, Architects, Engineers, and Project Managers. The rationale behind their selection is to get first-hand information about lean construction's Human Capital perspective since they comprise the main stakeholders.

Sampling size: The participants utilized for the interview are provided in Table 4-10 below.

Table 4-10 Interview participant size

	Invited	Participated
Quantity Surveyors	8	6
Architects	7	6
Engineers	8	6
Project Managers	8	6
Total Number of Participants	40	24

The number of participants for the expert opinion received was provided below:

Table 4-11 Expert Opinion participation size

	Invited	Participated
Lean Manager	3	1
Lean Coacher	1	1
Lean Practitioner	3	1
Continuous Improvement Manager	1	1
Lean Trainer	2	1
Total Number of Participants	12	5

4.5.4 Analysis of the primary data

The title of this research says *"Framework for Lean Construction Implementation from a Human Capital Perspective"* and the primary aim is to develop a viable framework for improving lean construction implementation from Human Capital perspective. To approach this research and ruminate on the workable approach to the research, we developed research questions from which interview questions were derived. A detailed literature review was conducted, and essential information was used in developing the interview questions. Considering the nature of the research, which is concerned with the professionals in the construction industry, the participants with a high understanding of construction and its associated management were considered for this research. The interview was conducted via online for each participant with the Covid pandemic issues. The mode of participation is not the bone of contention but rather, the information on the

construction industry was transcribed and stored in an Excel file (see Figure 5.1). These participants fall among the Architects (AR), Project Managers (PM), Quantity Surveyors (QS) and Engineers (EN). Each participant was presented with eight (8) questions, with their responses in rows and the questions in columns as indicated in the below figure 4-9. Furthermore, the Interview guideline for these interviews is attached as Appendix A.4.

1	emi-strucutred Interviews						
2			Q1	Q2	Q3	Q4	Q5
3	Interviewees		Role in the cor	Delivering projects on time within budget	Productivity & Efficien	Barriers / challenges	Human Capital Barriers
4	1	AR1	Project Archite	consider the fact the primary role of a project architect is to	My productivity is strongly inclined to my connection with	Considering the fact that changing from one approach to other requires time and patient.	Just as I said earlier for us to implement adv need to get our employees aware of what th all will be informed of what we aiming to ach
5	2	AR2	Principal Architect	This is a major challenge in my section as often times	Productivity is one of the main reason why we adjust our design.	Firstly, we identify the area(s) of the project that requires adjustment. Then based on our experience and	There are always challenges in implementin some considered it unnecessary most esec tends to show some lackadaisical attitudes.
6	3	AR3	Registered Architect	Delay can come from many channels and dealing with them also	Productivity requires a strict adherence to the design and the	Using advanced tools require us to deploy teamwork for collaborative acceptance. The occurrence of	I think lack of interest, lack of required skills, information/education.

Figure 4-9:Part of the raw Interview data.

4.5.5 Data Analysis

Obviously, the nature of the data is qualitative, implying that qualitative data analytics methods must be applied to infer the information within the data. Exploring the interview data requires adequate concentration and attention to the tone of the participant's responses to each question. From this, we can infer essential information suitable for coding and descriptive. To do this, the NVivo analysis application will be used to explore the data. In NVivo, we can read, jot down essential information (using memo), encapsulate an expression (using coding), visualize the information (using various chats) and export our results. In short, NVivo presents an excellent opportunity for this research and has been used to analyze the interview data. Figure 5.2 is an NVivo workspace sample showing many application features. In the figure, the interview was imported and analyzed. The analysis results are presented as “codes” and “charts (World Cloud).”

For better attention to the participant's responses to each question, each question and the responses were imported and analyzed separately. This can be seen in the “File” category of the codes; file number 3 implies that the code “awareness” was found in three files (in this case, three questions). The “Reference” section of the Codes implies the frequency of the code; that is, the word “project management” appeared 29 times in six questions. Lastly, in the Figure, one can visualize the

contents of a code by checking the “Word Cloud” of the code, as shown in Figure 4.10. From the results of “World Cloud,” much information can be obtained as it shows different words and their visual frequency. For instance, the words “project management” and “monitoring” appear frequently, and by relating them with other words with lesser frequency, we can infer information on the subject matter, such as how the word “monitoring” relates to construction management, resources, architectural design and so on. The below figures 4-10 and 4-11 illustrate the details of the data analysis.

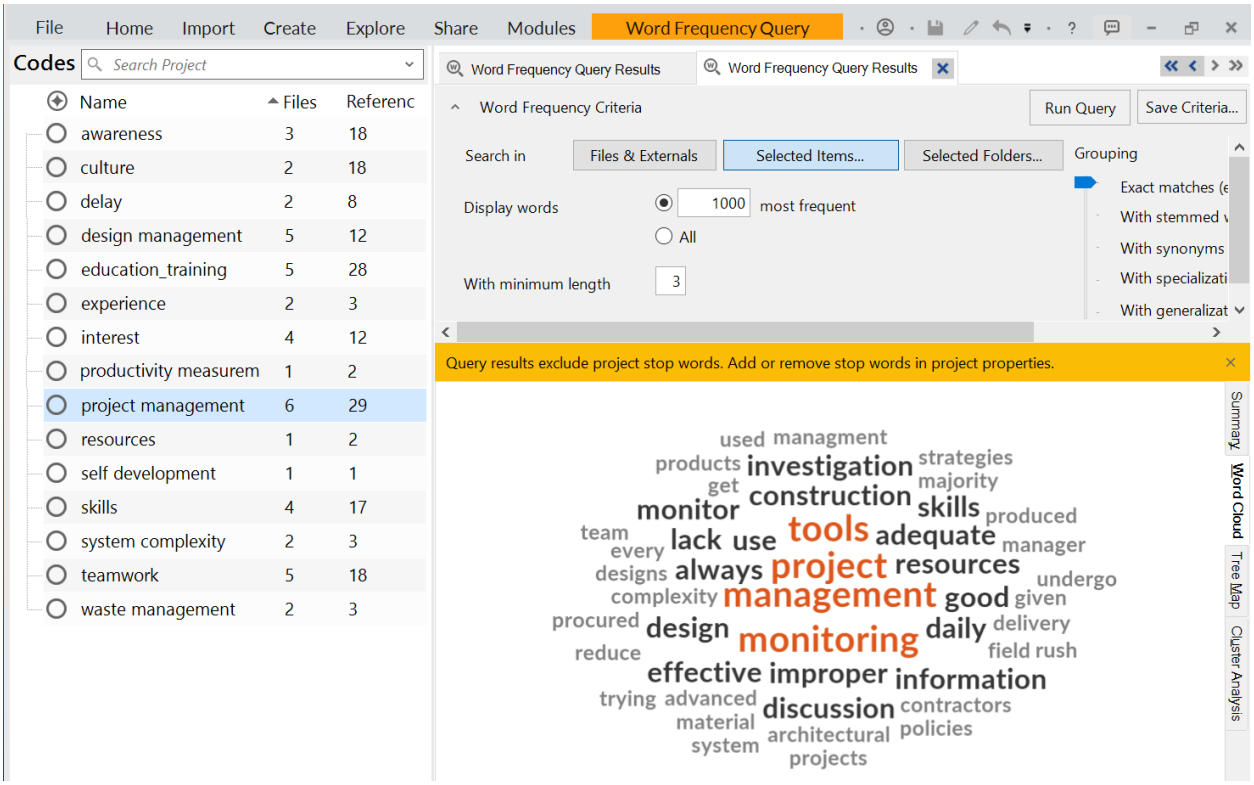

Figure 4-10: NVivo Workspace with the analyzed interview data

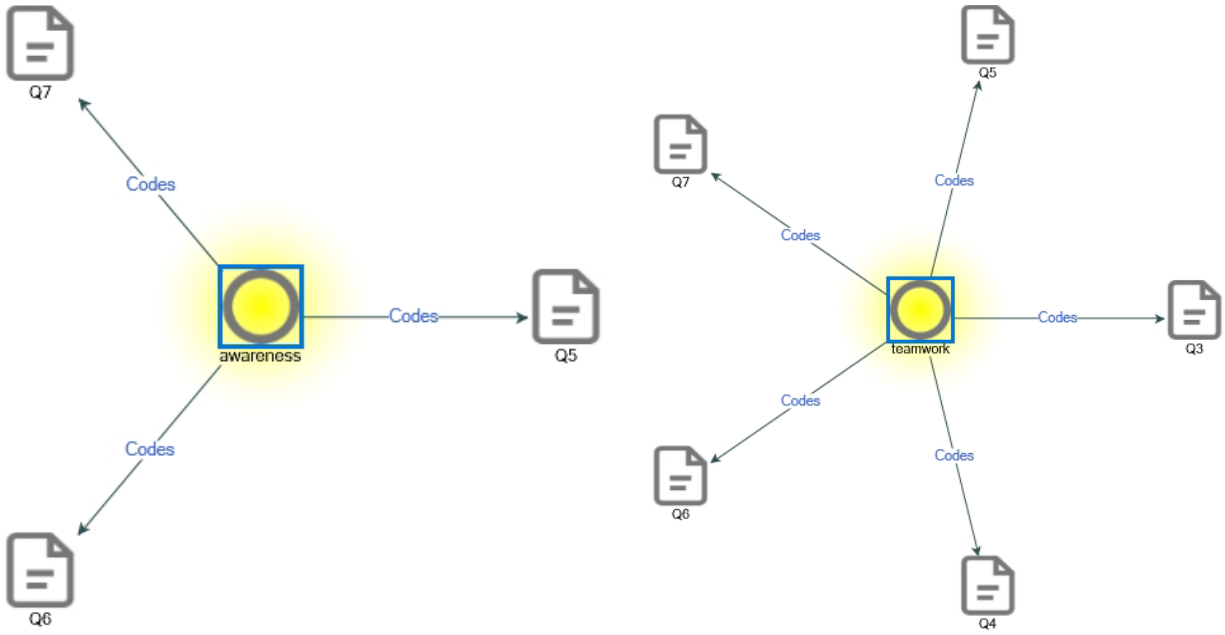

Figure 4-11: NVivo Workspace with the analyzed interview data

Figure 4.11 shows the explore diagram feature of NVivo, whereby each file containing a code is linked to the code. With this, one can easily track the content of each expression containing the code. The code "awareness," therefore, is found in three files (questions 5, 6, and 7), while the code "teamwork" is found in five files (questions 3, 4, 5, 6 and 7).

Thematic Analysis Methods

Thematic analysis was used to analyse the qualitative data-the interview questions. The thematic analysis involves the use of "interview extract," "codes," and "themes." "Interview extract" is a summary of a conversation with any of the participants, usually shorter. "Codes" are (if possible) a single word to encapsulate the content of the interview extract. Lastly, "themes" are categorical words used to group the "codes" (Braun and Clarke, 2012). All these categories are used to create a table, and the information is supplied. In this research, thematic analysis is used to infer information about the contents of the interview with the participants.

Figure 4-12: Thematic Analysis.

Interview extracts are expressions from the main text and often contain words describing important information about the subject matter. For instance, *"If we can fix communication in the construction industry, it would go really, really long way to help the other aspects of construction communication",* this expression talks about the role of communication in the construction industry, and it could be coded as "effective communication." Themes are another summary level for the extracts, and they are the final stage of data collection for the thematic analysis. Sometimes, themes and codes could be the same and could be different.

This section discussed the research methodology adopted for this research. Both secondary and primary data were collected to achieve the aim of this research; to develop a framework to improve lean construction implementation from a Human Capital perspective.

Next, the research methodology section is summarized in Figure 4.9. According to this figure, first, a conceptual framework was developed in two stages; Stage 1 (refer to Figure 2.2) based on the detailed literature review and Stage 2 (refer to Figure 3.3) based on the systematic literature review. The next step the research, the primary framework (refer to figure 6.13 and 6.14). Moreover, the primary framework was validated through expert opinions and the Framework to improve the lean construction implementation was developed (refer to Figure 6.17 to 6.19).

4.5.6 Summary of research methodology

The below figure 4-13 summarizes the research methodology carried out for this research.

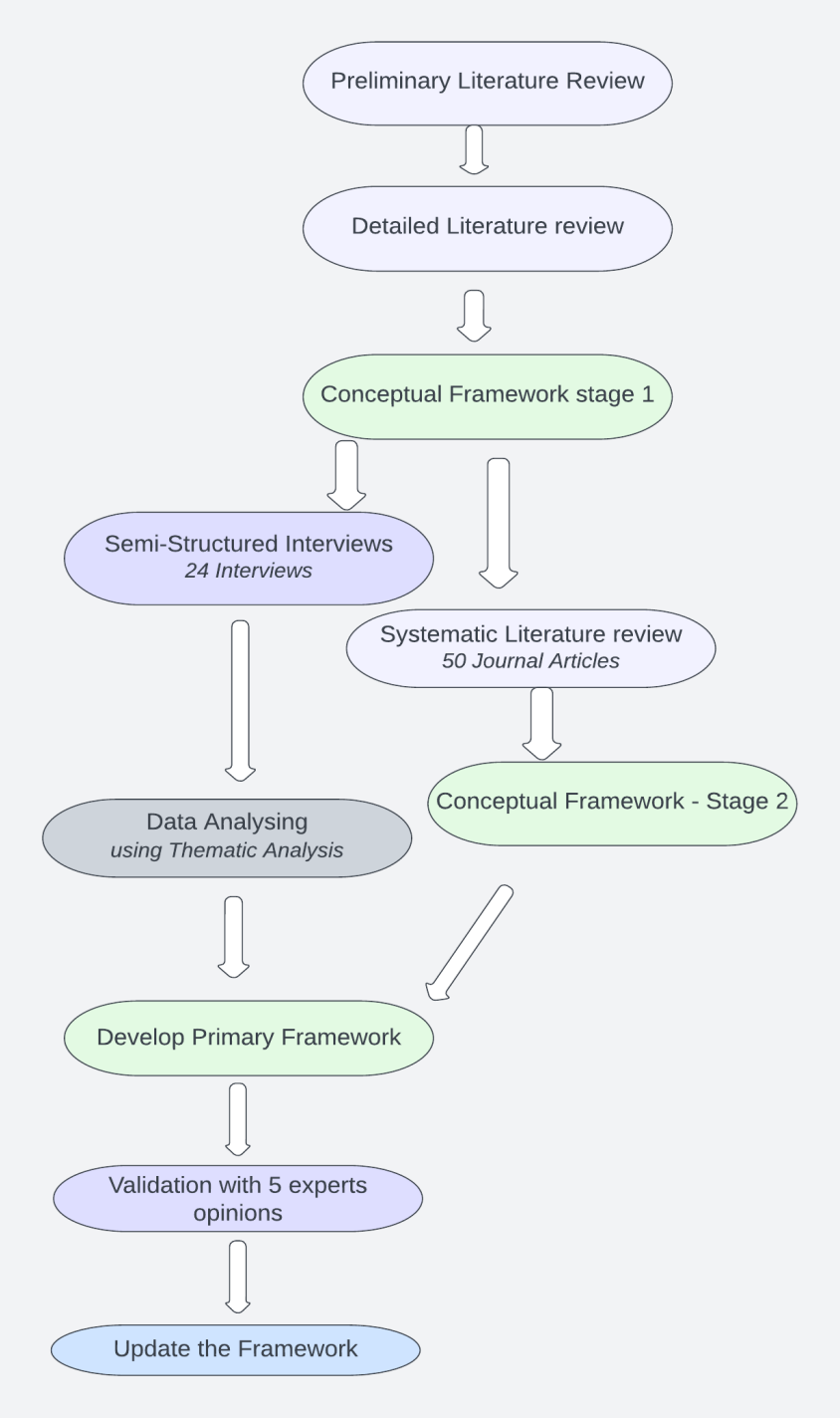

Figure 4-13 Summary of the research methodology

4.6 Chapter Summary

This section of the thesis detailed the tools and strategies used to achieve the study on 'how to improve the Lean Construction Implementation from the Human Capital perspective.' It used the research onion. As a result, it provided a detailed discussion of the steps of the research onion. It discussed the appropriate methods for each step. Importantly, it highlighted the chosen methods and provided an underpinned rationale behind the selection. The next Chapter presents the findings of the primary data with the analysis of data collected through semi-structured interviews and experts' opinions for validation.

CHAPTER 5 DATA ANALYSIS AND FINDINGS

This chapter presents the data collected through twenty-four semi-structured interviews and the five interviews carried out with five experts in Lean Construction Implementation. Table 5.1 shows the subheadings and contents of this chapter.

Table 5-1: Chapter 5 section headings and contents

Section headings	Section content
5.1 Introduction	Briefly presents the content of the chapter, including outcomes of the data collection methods
5.2 Background of the participants	The background of the participants who participated in semi-structured interviews is presented identifying their selection criteria.
5.3 Barriers to Lean Construction Implementation	The data analysis on the findings from the interviews are presented here to achieve objective one
5.4 Human Capital related barriers	Human Capital barriers are analyzed here to achieve objective two of this study
5.5 Strategies to improve Lean Construction Implementation	Interview data on strategies to improve Lean Construction implementation from Human Capital perspective is discussed in this section.
5.6 Experts' Opinions	This section presents the data analysis on the research findings from the interviews done with experts.
5.7 Summary	Summarizes Chapter five with a brief introduction to the next chapter.

5.1 Introduction

The previous chapter presented the research design and the methodology selected for this research. This chapter presents the primary data collected through semi-structured interviews and the experts' opinion. The collected data were analyzed using NVivo software and presented in this chapter. The aim of this research is to develop a framework to improve the Lean Construction implementation from the Human Capital perspective. As stated in the methodology of this research (see section 4.7), several approaches were used for this research to achieve the aim of the research. These approaches to data collection and their outcomes are stated below Figure 5.1.

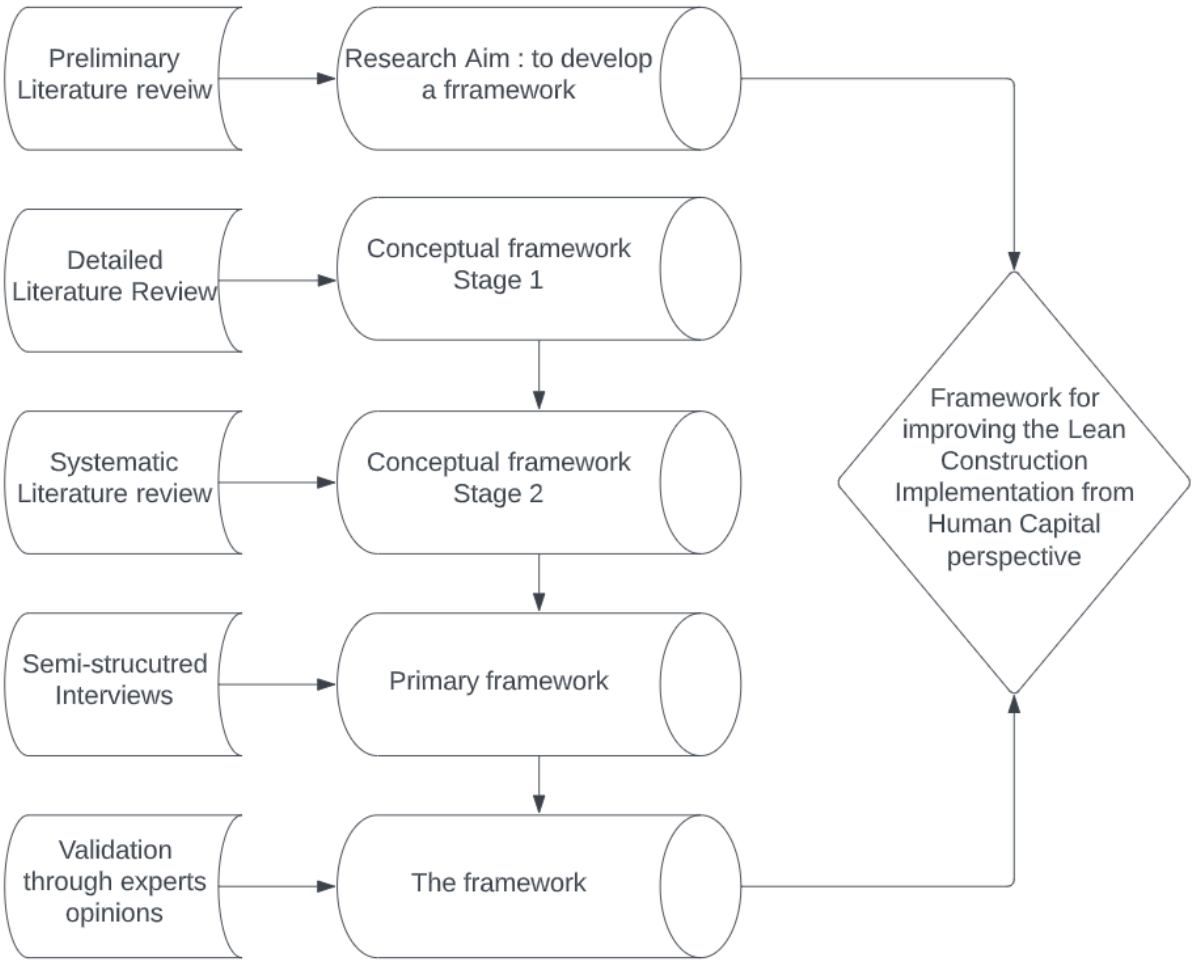

Figure 5-1 Research outcome and methodologies

First, a conceptual framework - stage 1 (see section 2.5) was developed through the detailed literature review. Secondly, semi-structured interviews were commenced to collect primary data to identify Human Capital barriers in Lean Construction Implementation and to assess the appropriate strategies to overcome them. According to the research design, twenty-four participants were identified to interview. As the next step, the researcher initiated to collect data to achieve the research objectives through a systematic literature review (see Chapter 3) while continuing the rest of the interviews. The barriers to Lean Construction Implementation and how these barriers are related to the Human Capital area were critically evaluated through this

systematic literature review. Moreover, the most critical barriers were assessed, and finally, the widely suggested strategies to overcome these barriers were explored. Conceptual framework stage 2 (see section 3.10) was developed to answer the research questions of this study. The primary framework (see Table 5.2 below illustrates how research questions were achieved through different approaches.

Table 5-2 Mapping data collection methods with objectives

Objectives	How to improve the lean construction implementation from Human Capital perspective?	Primary data	Secondary data
Objective 1: **To identify the barriers to Lean Construction implementation in the construction industry**	1: What factors affect the implementation of Lean Construction?		√
	2: What are the barriers to implementing Lean Construction?	√	√
	3: How are these barriers related to the Human Capital perspective		√
Objective 2: **To assess the Human Capital-related barriers to Lean Construction Implementation in the construction industry**	4: How to define Human Capital in Lean Construction Implementation?	√	√
	5: How to evaluate the barriers in Lean Construction Implementation from Human Capital perspective?	√	√
	6: What are the most critical barriers in Lean Construction Implementation from Human Capital perspective?		
Objective 3: **To evaluate the strategies for improving the Lean Construction Implementation in the construction industry from the Human Capital perspective.**	7: What are the widely suggested strategies to overcome Human Capital barriers in Lean Construction Implementation?	√	√
	8: What are the most suitable strategies to improve Lean Construction Implementation from Human Capital perspective?	√	√

Chapter 2 and Chapter 3 presented the secondary data collected through a detailed literature review and the systematic literature review. This chapter presents the findings from the primary data collected from twenty-four semi-structured interviews and five expert opinions to refine and validate the framework developed. Next, the background of the participants is presented.

5.2 The background of the participants

The research data were obtained from real-time interviews with the construction professionals in the New Zealand construction industry, which ranged from Architects, Project Managers, Engineers, and Quantity Surveyors as discussed in section 4.6.5 in Chapter 4. The conversations with the professionals in the construction industry were transcribed and stored in an excel file.

The key criteria in inviting the participants were: a) currently working in the New Zealand construction industry, b) minimum five years of experience in construction projects, and c) a member of the relevant professional bodies. All twenty-four participants met these three criteria. In addition to these key criteria, there were five preferred criteria namely: academic experience within their above disciplines, specific experience in Lean Construction Implementation, specific research in Lean Construction, publications related Lean Construction, and experience in special construction projects. One interviewee had the academic experience, and eight had the specific experience in Lean Construction Implementation. Also, two participants have completed research on Lean Construction and publications based on those studies. Two project manages said that they have experience in handling specific projects.

According to the information presented in the above table, all the participants had me the key criteria identified as A to C above. Also, only six participants had the experience in Lean Construction Implementation. However, most of the participants were aware of Lean Construction Implementation with sufficient knowledge on lean principles. AR02 and EN05 stated that *"lean is a way of managing the unnecessary activities, and there are many techniques which we can use in our projects."* Also, PM05, QS05 and QS06 pointed out *"a few techniques of Lean Construction are applied in New Zealand construction industry, but many more to implement to reduce waste."* The participants (PM 03, PM 05, EN 02 and EN 04) who had the experience on Lean Construction

Implementation mentioned several times during their explanations that *"Lean Construction needs to begin with the project initiation, there should be a proper mechanism to incorporate lean techniques into the construction process, the leadership is more significant."* Overall, all agreed on the importance of '*developing a Lean Culture"* in New Zealand construction industry to improve productivity and the efficiency to deliver the projects on time and within budgets. The next section discusses the barriers identified through the semi-structured interviews.

5.3 Barriers to Lean Construction Implementation in New Zealand

Each participant was presented with eight questions (see Appendix A.4). During the interview sessions, the barriers identified through the literature review (see Table 3.5) and the themes identified in section 3.8 were discussed in detail, the participants were asked whether there were any other barriers and strategies in New Zealand's context. The following section presents the responses received from the participants.

This section discusses the interview finding to achieve objective one: *barriers to Lean Construction Implementation in the construction industry.* The question was on the general barriers, and when analyzing findings, the below themes shown in Figure 5.2 were the most significant barriers.

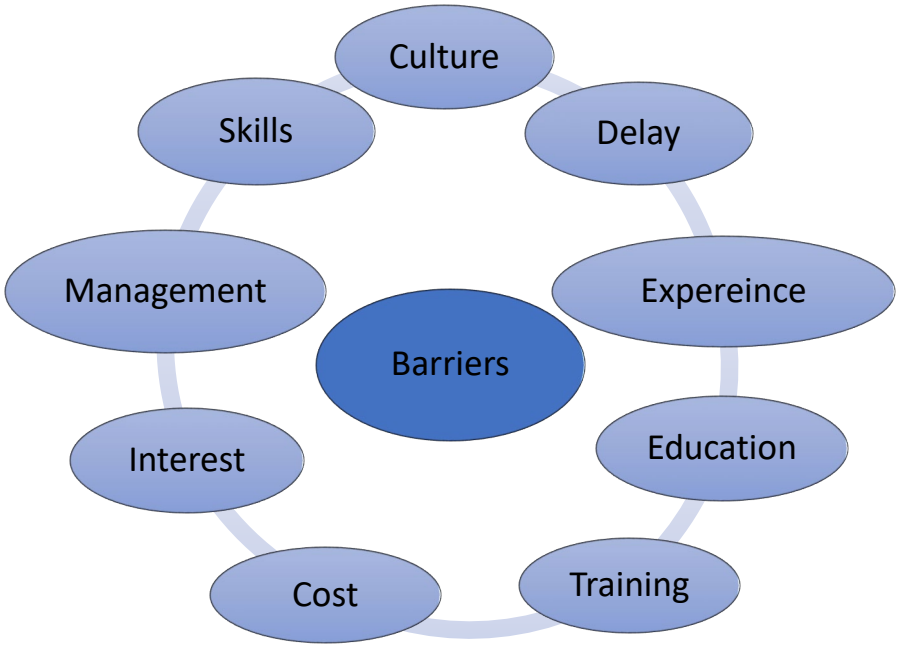

Figure 5-2: Codes classification into themes

Figure 5.2 above presents the classification of the codes derived from the interview data, as discussed in the following sections. There are primarily nine unique themes. The primary aim of performing this process of encoding into themes is to further probe the content of the interview data and to streamline the data to achieve the objective one which is to identify the barriers to Lean Construction Implementation. Data gathered for each of the themes is analyzed in the subsequent sections.

Culture

As mentioned above section, most of the participants mentioned frequently the word *"culture"* in their narratives and highlighted the importance of developing the Lean Culture. For example, AR01, PM02, EN05 said that *"In projects, there should be a tradition to practice lean tools and techniques as a duty or a function",* Similarly, EN03, QS03, EN01 highlighted as *"...and so, the culture is the most important thing I think.", "..., therefore if we develop such culture, construction workers are motivated".* Therefore, the absence of Lean Culture was identified as a barrier to implement to improve the productivity and efficiency issues in the construction activities using Lean Construction practices. When analyzing the data with NVivo, the words "lack", "characters",

and “drivers” are the most occurring. The word “lack” suggests that maybe some employees lack some characteristics or attitudes that promote the implementation of new management systems in the construction industry. This resonates with the previous information, and it can be inferred that the commitment and enthusiasm of the employees seem to be largely dependent on the cultural background influence on their characters. Thus, in approaching the strategies for implementing Lean Construction management, culture and its connection to the characters and attitudes of the employees must be probed thoroughly to identify a viable approach to solving the problems associated with culture.

Delay

According to the participant's response, it is an unavoidable recurring circumstance linked to many factors. For instance, *“this is a major challenge in my section as often times we have reason to adjust our designs and usually takes additional time and resources”* is the response of EN02. Delay is one of the derived codes from the participant's responses to the interview questions and is associated with delays from many angles, such as resources and human input. In the first category, the two most occurring words are “delay” and “allocation”, which could mean delays experienced in allocating funds, resources, or other contributing factors. This code mainly appeared in the question that investigates the project delivery on the due time. Many participants declared that the delay mostly comes from insufficient resources, In the second category, the presence of “experience” and “money” suggests that the delay could result from a lack of experienced personnel for implementing Lean Construction management or insufficient money for running a project. In addition, a delay could be as the circumstances may present or the delay caused by the suppliers. Lastly, regarding delay, it can be inferred that additional time and resources may be required to prevent future unforeseen circumstances such as design adjustments. Therefore, the implementation of Lean Construction must consider many factors that could cause delays.

Cost

Cost was a term mentioned by most of the participants at their interviews. AR03 said that *“any new management approach is an additional cost to the project when it comes to the training and education.”* PM 04 mentioned that *“the idea of appointing a lean manager would be an option,*

but again, it is an additional cost for the project." In analysing the interview data, the similar words cost came up such as "expensive", "price"," value" and "figures".

Education and Training

Majority of participants identified the education and training as a barrier to Lean Construction Implementation. According to PM03 "*lean is still new to university education*". QS02 and QS02 and AR05 stressed that *"most of us are unaware of these tools and techniques."* Also, from the interview data, the word "Education" and "Training" have frequently been identified. In construction projects which sometimes could last days, months, or even years, the act of training and educating the employees are usual occurrences. Education and training could relate to any part of the project, such as safety, management, security, etc. the code's content description can be seen by the arrangement of the words that make up the code. In the first category, the words "training" and "employees" are grouped, which intuitively suggests the training of the employees in the construction projects. Many of the participants made references to the educational level of the employees in tackling the Human Capital barriers in construction projects. This implies that in applying Lean Construction management to construction projects, education and training of the personnel is a critical barrier and must be investigated critically if the deployment of lean construction would be successful. For instance, the presence of the words "leadership" "orientation" and "awareness" suggests that the education and empowering the employees via training could be in form of leadership training, orientating the employees on some key information about Lean Construction and even the conventional management, and creating awareness about the essentials of Lean Construction. considered educating and training personnel as one of the critical success factors influencing construction projects.

Experience

As per the participants, experience is a key barrier. AR05 said that *"all depends on experience, others come next"* Experience refers to problem-solving using a practical approach to past events. This code was derived from the information obtained from the interview, and there are relatively fewer associated expressions when compared with others. In the first category, the words "experience" and "attention" are grouped. Several participants (AR02, EN03, PM04, QS04, QS05) suggested that "*experience of the personnel about, for instance, designs and management*

approaches is lacking." According to AR01 and AR03 "*sharing knowledge about a construction project is a good and workable approach to preventing errors and finding a solution to discrepancies."* Now to the subject matter, which considers the Human Capital barriers to the effective implementation of Lean Construction, the experience of the personnel with conventional construction management. Lean Construction has to be evaluated to identify the intersection which presents a good approach to fully integrate Lean Construction practices.

Interest

The majority of the participants mentioned the word "interest" during their explanations on the barriers to Lean Construction Implementation. According to QS01 *"lack of interest is a key challenge to implement new practices."* Whereas AR04 said that *"workers are resistant to new techniques and tools because they think that those are additional works for them"* can be defined as a state of wanting to know something or desiring to learn something. In other words, interest can be referred to as an inner force propelling someone to want to learn a thing. For instance, when someone has an interest in a particular process or activity, you may not have to compel such a person to carry out whatever their responsibilities are. The content of the words that make up the code "interest" can be found. Analyzing the words in the first category "lack" and "attitudes" suggests a lack of attitudes that backs up the interest or no interest of the employees in the construction projects. Considering that this research aims to provide a viable framework for implementing Lean Construction management in the construction industry, then investigating the enthusiasm and commitment of employees may be of good measure in evaluating the interest of the personnel in the construction industry. Therefore, the framework for implementing Lean Construction should be able to provide a measure for the evaluation of the interest of the personnel.

Project Management

As per the interview data, it is revealed that most of the participants have expressed about the management. AR05 and EN02 said that *"Project manager is responsible for a change."* Also, PM04 highlighted that *"who going to take the responsibility is the real questions."* Analyzing the contents of the code, it can be observed that project monitoring is one of the keywords the participants mentioned as the primary strategy to tackling Human Capital barriers in the construction project. There are words like "tools," "improper," "resources" "design" and so forth.

This suggests that project management could be regarding resources management, design management etc. Therefore, implementing Lean Construction should provide a framework that considers lapses associated with project management in construction projects. PM 02 suggested *"project manager should become the lean manger as well."* This could be in the form of having lean managers for the projects.

Skills

From the interview data, it has been observed that skills have been made frequently by the participants, such as in the case of Human Capital barriers to construction projects and strategies to overcome them. the content of the words that make up the code suggests that skills acquisition is one of the main approaches to implementing a management technique in construction projects. AR05 said that *"skilled people are not available and there is a lack of professionals coming to the construction industry, maybe they opted other industries for some reasons."* EN02, EN03, PM05 suggested that the lack of skills of the personnel in construction management is a constraint to implementing Lean Construction. Therefore, skills acquisition may be an excellent approach to this challenge. Hence, the framework of Lean Construction management should be able to present an approach to preventing lapses in conventional construction management.

This section discussed the barriers to Lean Construction Implementation. The next section presents the findings for objective two, to *assess Human Capital-related barriers to Lean Construction Implementation in the construction industry*.

5.4 Human Capital-related barriers to Lean Construction Implementation.

In the literature review, the significance of developing a Lean Culture was discussed, and the below figure 5.3 illustrates the key themes identified as the Human Capital barriers and the suitable strategies (see section 3.8). The same themes were used to analyze the findings from the interviews.

Figure 5-3 Barriers to developing a Lean Culture.

Next, data analysis based on the findings of each theme from the semi-structured interviews is presented.

Attitudes

Majority of the participants stressed "attitudes" as a barrier to Lean Construction Implementation. EN01 stated that *"lean implementation is usually a new change to employees and top management, which may become stressful and uncomfortable*" whereas QS 03 stated that *"I agree that lean is a new way of managing projects for its success, but it is an additional burden to the construction workers."* Most of the participants pointed out that *"construction workers are working under a stress for many reasons and this type of new practices maybe an additional pressure to them."* Moreover, PM04 and AR02 said "it is important to consider the psychology of the construction workers." Several Participants (AR03, EN04, EN05, PM05 and QS03) highlighted *"the resistance of the construction workers to learn new philosophies. Instead, they tend to practice new technologies, software, and machine aid experience".* When analysing data through NVivo, in the first category, "attitudes" and "differences" are the two words, and when combined, they give the word "attitude differences." In analysing the word "culture", the attitude of the involved member

of the public is the first indicator of the culture of a group of people. Therefore, the code "culture" has attitude differences as the most occurring word. This suggests that cultural differences are one of the leading barriers to implementing Lean Construction.

Awareness

All the participants mentioned the word "awareness" during their interviews. "*Lean Construction practices are new to us*" was frequently mentioned by the participants and they stated that "*awareness through other cases*, "…being updated," *"lack of awareness of such practices."* Particularly, EN04 stated that *"we all need to wear the lean lenses from the beginning of the project to see the construction activities through lean lenses."* According to PM 03, *"we need to aware that Lean is a philosophy rather a tool or technique.*" Similarly*,* AR04, EN01, QS03 and QS04 highlighted that *"…. need to see things through lean window."* Moreover*,* PM 02 said that *"people's viewpoints matter a lot……"* Furthermore, AR03, PM01, and EN04 mentioned that *"as professionals, our awareness of new approached such as lean, BIM or similar is significant in completing the project on time"* whereas QS02 and QS05 stated that *"we can complete projects within the budgets if we know how to minimize the waste from the beginning."* Therefore, these findings revealed that awareness about Lean Construction Implementation is vital.

Education

Education was discussed by a wide range of the participants as important. AR03 stated that *"Education has a lot to do with the success of new approaches like lean."* Similarly, EN04 highlighted that *"not only the construction workers but also the top management needs to be educated on what is lean."* PM 03 talked about *"limited connection to the school's system."* Most of the participants agree to *"With adequate knowledge in place, the implementation and success of the Lean Construction."* PM 04 EN04 and QS05 described the importance of *"introducing the Lean Construction in to School and tertiary education."* The ideas of AR02 and QS05 were *"lean education should not be a separate learning process; it is better be a part of the construction education."* Also, PM 03 stated that *"it is important every construction diploma holder to have a basic knowledge in new approaches like lean techniques before they enter in to construction field."* Therefore, it is revealed that education is a significant barrier to implementing Lean Construction.

Interest

The word "interest" was mentioned by all most all participants directly or indirectly when they identify the barriers to Lean Construction Implementation. The words "resistance" and "lack of interest" mentioned by most of participants within their explanations of Human capital barriers. It was evident that the interest plays a major role in implementing new approaches as Lean Construction. EN 05 stated that *"....and the new approached like Lean, the employees take as additional work to them and try to ignore."* Capabilities and competencies are the characteristics of the "Human Capital". Several participants highlighted that construction professionals and workers need appropriate capabilities to minimize the waste and increase efficiency and productivity. QS01 emphasized that *"most capable people should lead the project"* whereas EN04 and PM05 stated that "*capabilities are not just qualification, but soft skills such as teamwork, effective communication…".* All most all participants supported that *"interest of the construction people is essential, especially when new management approaches are implemented."*

Leadership

AR02 discussed the importance of the leadership saying, *"we need a competent captain, first."* Also, EN05 mentioned that *"it is impossible to implement new approaches when there is no good leaderships."* QS01 stressed that *"Leadership needs to take these initiatives."* In general, all the interviews discussed about the importance of having an experienced leader to complete the project journey it's success. Project management is a broad concept that involves applying many processes and systematically implementing knowledge or skills and tools to deliver the project within the planned constraints. In other words, project management can be defined as a process of leading a project through each phase to achieve the project's aim and objectives within a given time and resources. Project management has been considered one of the most crucial success factors in construction projects. Project management involves many activities that still boil down to the Human Capital factor, such that deficiency in Human Capital leads to a barrier. In contrast, adequate Human Capital, such as skilled personnel in project management, leads to a positive impact.

Teamwork

All participants stress the importance of teamwork, and they recognized that as a barrier. QS 05 said that *"...maybe of lack of cooperation of the employees and inadequate teamwork."* Also, EN03 and PM03 mentioned that *"in construction, we do not have individual goals" and "we need to work as a team to achieve the project goals, but unfortunately, some professionals do not think so."* In this regard, teamwork becomes a critical barrier to Lean Construction Implementation. After the design and materials quality evaluation, it is an excellent choice to focus on how the personnel from different teams will work together to achieve a common goal of delivering a project with high customer satisfaction and continuous improvement. People that make up a company serve as the number one factor enabling a culture's operation. Some consider culture as a collection of life experiences brought to an organization by each employee.

Training

AR01 said that *"lack of training because the project schedules are tight."* QS02 stated that *"budgets are insufficient for adequate training."* PM 04 highlighted that *"continuous training is a must." Also, PM03 talked about lack of "work-ready training"* and *AR04, EN03 and QS05 believe "less industry connection to training." Moreover,* PM02 stressed that *"there is a limited supply of trainers."* Most of the interviewees mentioned the lack of training due to various reasons. The word "training" appeared in all participants' transcriptions. All most all, the interviewees said the words "awareness", "knowledge", "skills", and "training". Therefore, this theme was not selected to the next step of data analysis.

Accuracy, capability, information, and philosophy

In the above section, as per the figure 5.3 above, there are ten themes identified through the literature review. However, when analyzing the interview data, it was revealed that accuracy, capability, information, and philosophy were not mentioned by the participants during their discussions as the Human Capital barriers. Therefore, accuracy, information and philosophy were excluded from the list of themes. However, AR01 said that they *"need proper information to be aware of the particular activity"* during his explanation on 'awareness', Similarly EN03 and PM04 mentioned that "… *understand that lean is not a technique, but it's viewpoint when they expressed their opinion on attitudes.*"

In summary, ten themes were analyzed based on the research findings, and seven of them were recognized as per figure 5.4 below. and accepted as barriers to the Lean Construction Implementation. Human Capital is the knowledge, skills, and capacities of persons and therefore, it is evident that most of the barriers are related to Human Capital area.

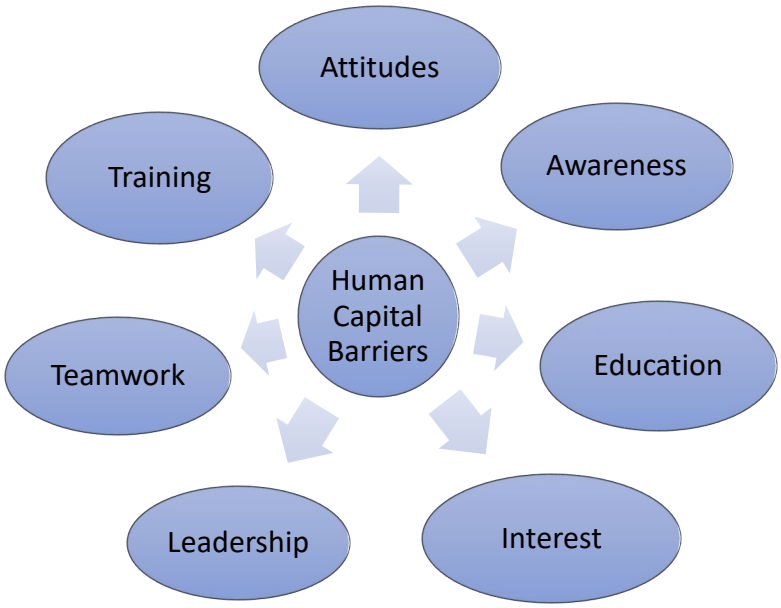

Figure 5-4 Themes of Human Capital barriers

In summary, from the interview data with the participants in this research, the following barriers to the implementation of Lean Construction have been identified and highlighted:

- Limited connection to the school's system
- Lack of support for work-ready training and industry connection
- High cost of training, limited supply of trainers
- New entrants and employers have vastly different expectations.

The next section analyses the findings related to Objective three which is to evaluate the strategies for improving the Lean Construction implementation in the construction industry from the Human Capital perspective.

5.5 Strategies to improve Lean Construction Implementation

This section presents the data finding and analysis on the strategies to improve the Lean Construction Implementation. As per the interview data, all participants agreed attitudes, awareness and leadership is key barriers to Lean Construction Implementation from Human Capital perspective.

Awareness

The most participants expressed their opinions on how to overcome the awareness as a barrier. PM 02 said that "key valves need to display in the project for everyone to see,". Similarly, QS01 mentioned that "the word lean can use everywhere when it is possible". Also, EN03 mentioned that "Constant reference to the word lean". Moreover, AR05, EN04, PM01 agreed to that "…we need to get our employees aware of what they are all about". Furthermore, EN05 mentioned that "*Firstly, we identify the area(s) of the project that requires adjustment. Then based on our experience and commitment, we use our skills to effect the changes*." Awareness, education, skills, training were used by the participants to explain the strategies to improve the awareness. However, a few interviewees mentioned the engravement of the key core values of lean and the constant reference of the word lean are the strategies to improve awareness.

Leadership

All participants involved in expressing their opinions on how the leadership is effectively improved to implement new approaches such as Lean Construction. EN03 and QS 03 said that "the question is who is the Leader? PM 04 and AR05 discussed *"extending the project management role incorporating the scope of lean."* EN03 and AR02 mentioned the possibility of "*the health and safety manager might be an option to execute the role of lean manager."* Moreover, EN01 and QS04 mentioned that *"the lean manager or the person who is responsible for lean implementation should join to the project at the very beginning to manage the project to minimize waste."* All participants recognized that there should be a 'single point responsibility" to manage the project from lean Construction perspective. According to them, the most suitable designation is Lean Manager.

Attitudes

All participants contributed to assessing the most appropriate strategies to overcome the barrier of attitudes. They suggested several strategies such as *"lean mindset, dinner outs, selfies with leadership."* Most of the participants stated that they are affected by the Lean Construction Implementation, and the strategies were suggested to improve the Human Capital area. All participants expressed that the attitudes of the people working in the construction industry need change positively, especially when new approaches are introduced to reap the benefits. AR03 emphasized that *"Changing workers mindset is most important".* Also, QS05 said that *"workers need to be considered as a part of the system"*. Moreover, EN02 mentioned the importance of "*understanding the final goal of the project as a corporate achievement, not about individuals, performance".* Furthermore, AR-1 said, *"always appreciate the people with greetings".* Importantly, PM 03 mentioned that *"organizing the events such as dinner outs with the leadership"* is important in changing the mindset of people. EN03 suggested that *"taking a selfie with chief executive officer* would be better for workers to feel that they are in the team.

Education

All participants mentioned that Lean Construction Implementation can be improved. QS05 said that *"the institutions such as New Zealand Institute of Quantity Surveying can launch the short course for Lean Construction". PM04 mentioned that* "*a few lean coaches are in New Zealand and the project Manager can link to them and get their service might be a good start"*. Moreover, "*Lean is limited to Tertiary education only in some institutions, but this can be extended to all tertiary programs".* Also, PM 04 stressed that *"the school is the best place to plant this new idea by accommodating Lean into NCE level curriculums".* Furthermore, EN04 mentioned within the conversation, *"educate the involved personnel while working is important, do not assume that they should know a thing".* All participants recognized the importance of increasing the level of education of the construction professionals and as well the workers on Lean Construction by suggesting "short courses, incorporating lean into school syllabuses, get the service from a lean coacher.

Training

Training was identified as a key barrier to Lean Construction Implementation as discussed in section 5.4. Moreover, the participants expressed their opinions how to improve the training of people in Lean Construction in the construction industry. AR02 said that "*training should be in the construction schedule"*. Also, QS05, PM01 and EN03 mentioned during their conversations *"……on the job training is recommended"*. Moreover, PM02 stressed that *"training on various available tools is required"*. According to QS03, *"technical aspects of the training will help workers to arm with Lean Construction Implementation"*. Furthermore, PM05 and EN04 emphasized that *"allocating sufficient budgets is important"* Training was recognized as an essential part of the construction processes, and all participants suggested the word "workshops" and "technical aspect" in training.

Interest

Resistant to change was identified as a barrier to Lean Construction Implementation. Therefore, "interest" was mentioned by all most all the participants during their explanations regarding the strategies to improve lean Construction Implementation. AR03 mentioned that *"Convey the message properly from top to bottom"*. This is about communicate the need to become lean in projects from senior management to the last planner or worker in the chain of the labour force. Also, PM05 and QS01 stressed that *"we need to use the proper language…"*. Moreover, PM03 said that "*workers like to follow the short instruction."*. Furthermore, PM05 and QS04 mentioned that *"If we can fix communication in the construction industry, it would go a really, long way to help the other aspects of construction communication"*. Also, AR04 said that *"…a lot of the principles behind Lean. what really interested me because I've got a kind of a wider view"*. Most of the participants recognized that effective communication may improve the interest of other in using Lean Construction practices.

Teamwork

More than half participants stated that teamwork need to be improved to implement new approaches such as Lean Construction practices. PM01 mentioned that "*a role model better be there to follow". Also,* PM03 commented that "*Lean manager can set up the team with effective communication*". Moreover, QS01 mentioned that *"attitudes, education and training help to build*

up the teamwork". Also, AR05 and EN01 mentioned about the development of capabilities of the construction professionals and stated that *"teamwork is one of the key capabilities of any professions"*. Also, PM02 mentioned that "*training is a part of the job and not an additional task".* Moreover, *AR04 and EN04 said that "there are institutes for training in New Zealand".* Training was recognized as an essential part of the construction processes, and all participants suggested the word "workshops" and "technical aspect" in training.

The above section discussed the data finding and analysis of the strategies to improve the Lean Construction Implementation. At this stage, a primary framework was developed to achieve the aim of this research (see section 6.2.5). The next section presents the findings and data analysis for expert opinions obtained to refine and validate the primary framework.

5.6 Expert Opinions for validation

This section presents the data obtained through experts' opinions to refine and validate the framework developed.

5.6.1 Introduction

After analysing the primary data, the framework was proposed, and expert opinion was sought to refine and validate the framework. The following framework shown in figure 5.25 was presented to the experts to obtain their opinion. Experts commented on the framework by answering the semi-structured questions raised at the online face-to-face interviews. The interview guideline with the information sheet and the consent form is attached as Appendix A to this thesis. The primary question is how to improve this framework within their expertise. The answers were transcribed, and their views about the subject matter have been analyzed. In summary, the opinion of the experts with regard to the effective operation of Lean Construction in New Zealand is discussed below.

5.6.2 The background of the experts

Five experts are comprised of Lean Manager, Lean Coacher, Lean trainer, Lean Practitioner, and Continuous Improvement Manager. All had more than ten years of experience and two of the group are over twenty years' of experience. Lean Coacher is trained personnel with lean practices who gives the input to solving problems in the construction projects where there are issues, especially in workflow. The Lean Trainer is a qualified professional working in a reputed construction training organization who supports the construction groups to get trained with lean tools and techniques. Whereas the Lean Manager is a client-appointed single point responsible person from inception to the completion of the project who look after the process flow running smoothly as per the construction program by implementing lean tools and techniques to make sure in achieving the project objectives on time withing the budget. The Continuous Improvement Manger is an engineer by profession who has been trained to maintain the best practices and improve them when and where necessary when a project is progressing. All the experts had sound knowledge about Lean Construction Implementation and the intervention of Human Capital.

5.6.3 Analysis of the findings

On the aspects of delivering projects on time, the interviewed experts were open enough to explain the challenges facing the construction industry in terms of delivering projects on time. Virtually all the participants across the level of experts declared that having delays in delivering construction projects is a frequent occurring circumstance, and they have attributed this delay to various factors. The most common factor is related to the architectural design of constructions, as often the adjustment may lead to a request for additional time and resources. Another factor that the experts also pointed out is the lack of teamwork among the workers, whereby a team responsible for a part of the project tends to consider only that as their responsibility, thereby delivering work that may end up giving the other teams challenges.

EO2 said that *"That is the aim, but not always the situation. "Also, PM02 and EN04 commented that "It depends on the money allocation at the beginning".* Moreover, QS03 said that *"I have seen one project that took 2 years, but the original duration was 9 months".* From this, it can be inferred that a lack of sufficient resources, such as funding, also caused delays in construction projects in New Zealand. Lastly, the participants also associated delays in construction projects

with the materials evaluation prior to their application. They responded that sometimes the materials delivered by the partnering companies do not meet the standard for the project, and consequently, they are often returned, and this may take a longer time for replacement. Thus, time and resource overruns are common in construction projects.

On the aspect of productivity and efficiency of Lean Construction, the experts gave their views on the subject matter. This is a very important aspect of construction, and the participants related it to many factors, all pointing toward the accuracy of the projects. In the pursuit of accuracy, many other things happen, and this can lead to delays, which also eventually point to resource and time overruns. According to EO5 *"my productivity is strongly inclined to my connection with other personnel.* EO01 mentioned that *" For instance, when I identify a strength or weakness in our operation, I often consult the related sections to discuss how to harness the strength or improve the weakness".* And it can be inferred from this response that teamwork is a key factor in improving productivity and efficiency in construction projects in New Zealand. This factor also appeared in the first section of the experts' opinions, which deals with the projects' delays. In addition, EO2 mentioned that *"productivity is one of the main reasons why we adjust our design." Furthermore,* EL04 said that *"When we notice a need to add or subtract something from the architectural design, we work with other people to implement a workable plan for the adjustment."* Architectural design and its modification to suit the project's predesigned purpose also are causes of productivity and efficiency in New Zealand. In the process of ensuring the accuracy of architectural design so as to improve productivity and efficiency, delays do occur. Linking these with the experts above, we can infer that teamwork and design modification are two factors that can influence project delivery time, productivity, and efficiency.

On the aspect of barriers facing the effective implementation of Lean Construction in New Zealand, the participants pointed at many barriers based on their experience, but communication was referenced by almost all the participants, be they directors, engineers, quantity surveyors, and the rest. They affirmed that the lack of awareness causes most of the barriers that Lean Construction faces in New Zealand. The participants believed that creating good communication within the sector can significantly handle other barriers such as lack of interest, unsupportive attitudes from the management, etc. The participants reiterated that immersing the construction

sector in Lean Culture would open the door for the effective operation of Lean Construction in New Zealand.

5.6.4 Experts' suggestion to validate the framework.

Experts' opinion on the suggested framework to improve the Lean Construction Implementation from the Human Capital perspective.

Lean Culture

All five experts agree to the main theme of the framework to be as Lean Culture. Further they emphasized the significance of people wearing lean lenses when they perform their activities to achieve the construction project objectives. Generally, waste means tangible / physical waste, but within Lean Culture the waste refers to *"waste of flow activities"* which are non-value adding activities. Therefore, EO3 and EO5 suggest rewording this to avoid the misunderstanding about waste. Also, *'continuous improvement of the process flow'* was suggested by EO4.

Education

EO3 explained that lean education must start from the school curriculums and essentially in tertiary education as a module for all construction-related built environment programs. On the other hand, EO04 stresses that the people who already work in the construction industry including construction professionals can be educated through practice via lesson-learned practices.

Attitude

EO1 and EO4 emphasized that the right attitude plays a major role, and the attitude can be changed through training, awareness, and education. Lean practices and techniques are developed to change the viewpoint, those are not additional or extra activities to consume more cost or time. The subtheme "analysis" had better be changed to represent the viewpoint.

Interest

All of the experts suggested that attitude, culture, and interest are somewhat similar when we look at the examples of the barriers such as "resistance to change, negative attitudes, and cultural barriers within multi-cultural set up.

Culture

EO5 and EO1 suggested that the main theme is Lean Culture, and this sub-theme is not related to Lean Culture, and it should be properly differentiated. With the shortage of skilled people, the multi-cultural working setup is very normal, and each culture has a different set of values. This is again related to attitudes, and attitude and culture can be considered as one theme rather than two different themes.

Teamwork

Onboarding was highlighted by EO3 because the appointment of the best team members is important in implementing lean practices, whereas establishing a lean mid-set was proposed by EO5.

Leadership

EO5 and EO1 discussed introducing a single person responsible for each construction project as a lean leader/ lean manager from inception to completion to minimize the non-value adding activities. On the other hand, EO4 discussed the requirement of a lean leader, but how it is different from the existing project manager is a question. Also, EO5 stated the importance of identifying cluster leaders for lean implementation.

Training

All experts emphasized the significance of training to behave and commit by learning the system and working in a feeling of trust, transparency, and collaboration to eliminate the non-value adding activities, which are waste.

Communication

Communication exists as a new theme within the expert's opinion. Each expert mentioned the lack of communication in implementing lean practices and the strategies to improve communications.

5.6.5 Summary of the Chapter

This chapter presented the findings from the interviews carried out to achieve the objectives of this study. There were 24 interviews with construction professionals in the New Zealand Construction Industry. Interviews revealed that there are barriers to Lean Construction Implementation, which

can be overcome by implementing various strategies from Human Capital perspectives. When analyzing findings, it is revealed that some of the themes identified in the literature (accuracy, information, and philosophy) were not mentioned by the participants. Therefore, these themes were excluded from the framework. Moreover, experts' opinion was sought to refine and validate the framework, and it was revealed that "communication" as a new theme was included in the framework. The next chapter is on the discussions of primary data compared to the literature and development of the framework.

CHAPTER 6 DISCUSSIONS

6.1 Introduction

The secondary and primary data were collected and analyzed to answer this research question as per the research design discussed in Chapter 4. Chapters 2 and 3 presented the secondary data collected and analyzed, whereas Chapter 5 presented the primary data findings and analysis. This Chapter interprets and explains the results. First, the research problem, research question, aim, and objectives are restated, then the findings are summarized, presenting the framework developed through this study. Next, this section interprets the results by unpacking the aim and research question by comparing results and supporting literature. Finally, the achievement of the objectives of this research is discussed. Table 6.1 below illustrates the subheading and contents of this chapter.

Table 6-1 Chapter 6 section headings and contents

Section headings	Section content
6.1 Introduction	Introduction to the chapter with a brief overview of the other chapters already presented. Moreover, this section restates the aim and the research question of this research.
6.2 The framework	The developed framework is presented using a graphical representation and described clearly in this section. This framework was developed in several stages, including refinement and validation. This section discusses these stages and how the framework is developed using primary and secondary data findings.
6.3 Interpret the results	This section presents the results from the research highlighting the scientific contributions of the study. These discussions covered the comparison of secondary and primary data for each theme identified to describe strategies to overcome the associated barriers in Lean Construction Implementation from a Human Capital Perspective.
6.4 Achieving the research objectives	There are four objectives, and this section describes the achievement of each objective of this research.
6.5 Summary	This section summarizes Chapter 6 with an introduction to the last Chapter, which is Chapter 7.

Research gap of this study was identified as Lean Construction Implementation is insufficient without commitment, great employee competence, good leadership, long-term connections with partners, and other human characteristics (see section 1.1.4 in Chapter one). Hence, the research question emerges: *How to improve Lean Construction Implementation from Human Capital perspective?* Figure 6.1 below illustrates the steps taken to answer the research question.

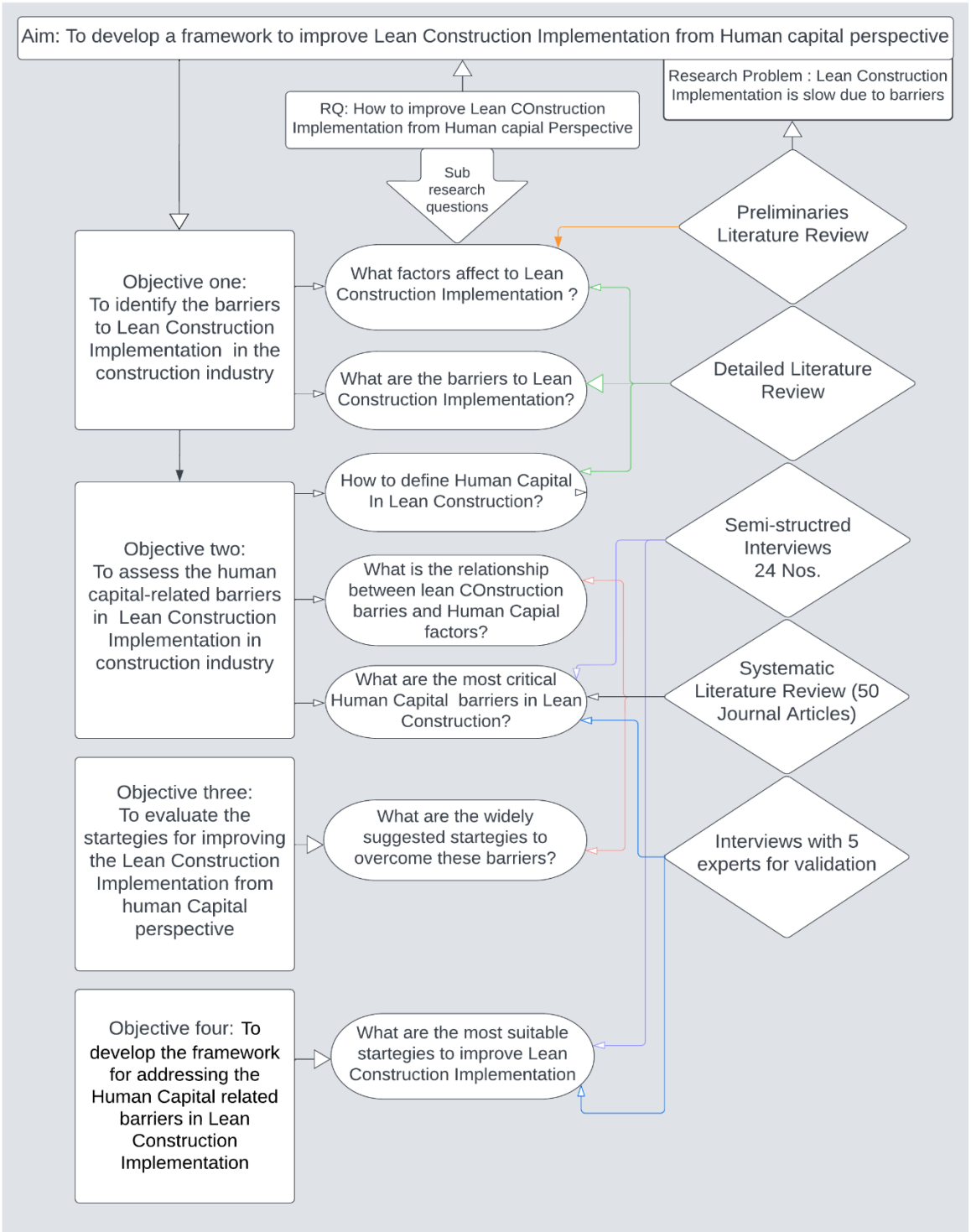

Figure 6-1 Steps taken to answer the research question.

The above figure 6.1 shows that the research question is analyzed to sub-research questions to achieve the objectives and how each sub-question is answered with different data collection methodologies. Finally, a framework was developed to answer the research question *How to improve Lean Construction Implementation from Human Capital perspective?* and the next section discusses this framework.

6.2 The Framework

This research aimed to develop a develop a framework to improve the Lean Construction Implementation from the Human Capital perspective. The following section discusses the development of this framework.

6.2.1 Development of the framework

The developed framework comprises the strategies that can be implemented to enhance the Lean Construction Implementation to defeat the barriers related to the Human Capital area. Development of the framework included several steps commencing from a conceptual framework, then building up to a primary framework and finally refined and validated to achieve the framework. These steps are illustrated in Figure 6.2 below. The first step was to develop a conceptual framework (see section 2.5) through a detailed literature review. The purpose of this conceptual framework was to design the research to collect data, analyze and interpret them. Next, this conceptual framework was further developed through a systematic literature review (see Figure 3.10). The conceptual framework derived common themes to barriers and strategies to Lean Construction Implementation from Human Capital Perspectives.

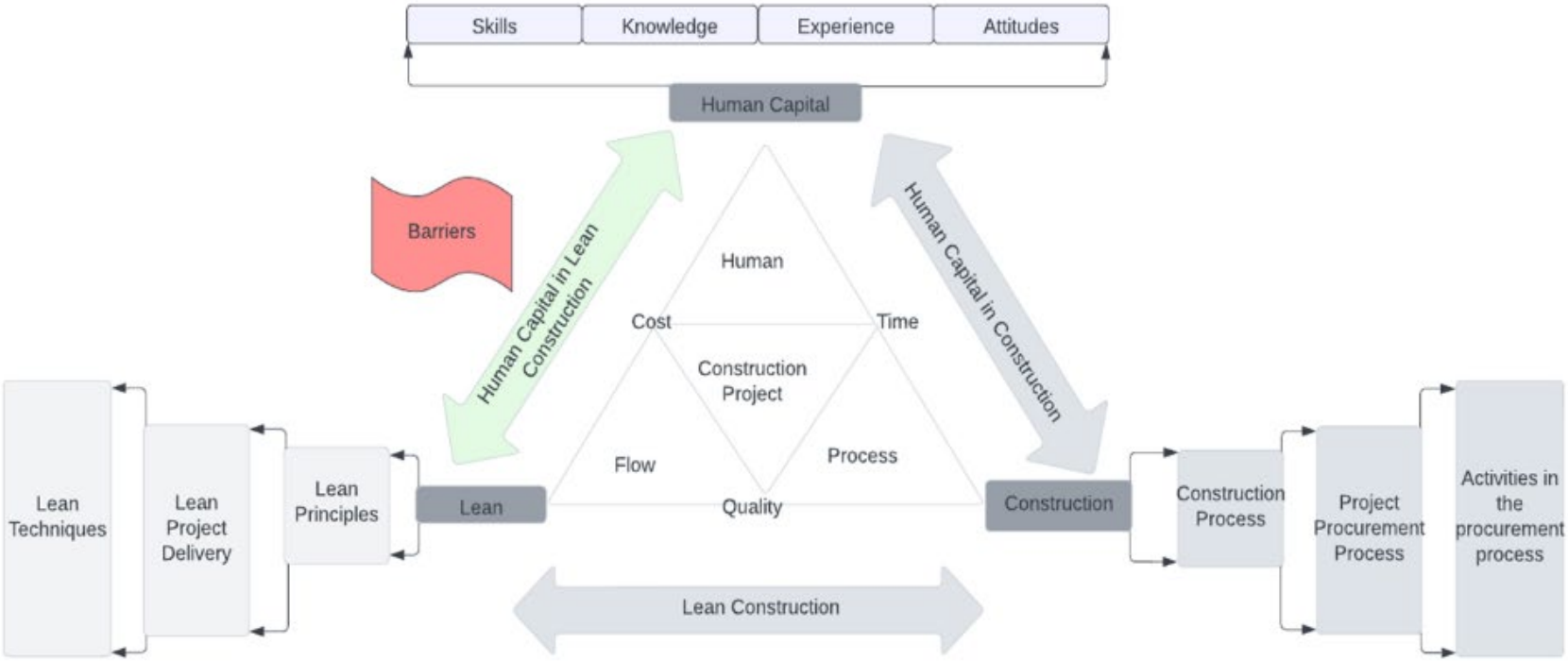

Figure 6-2 Development of the framework Stage 1

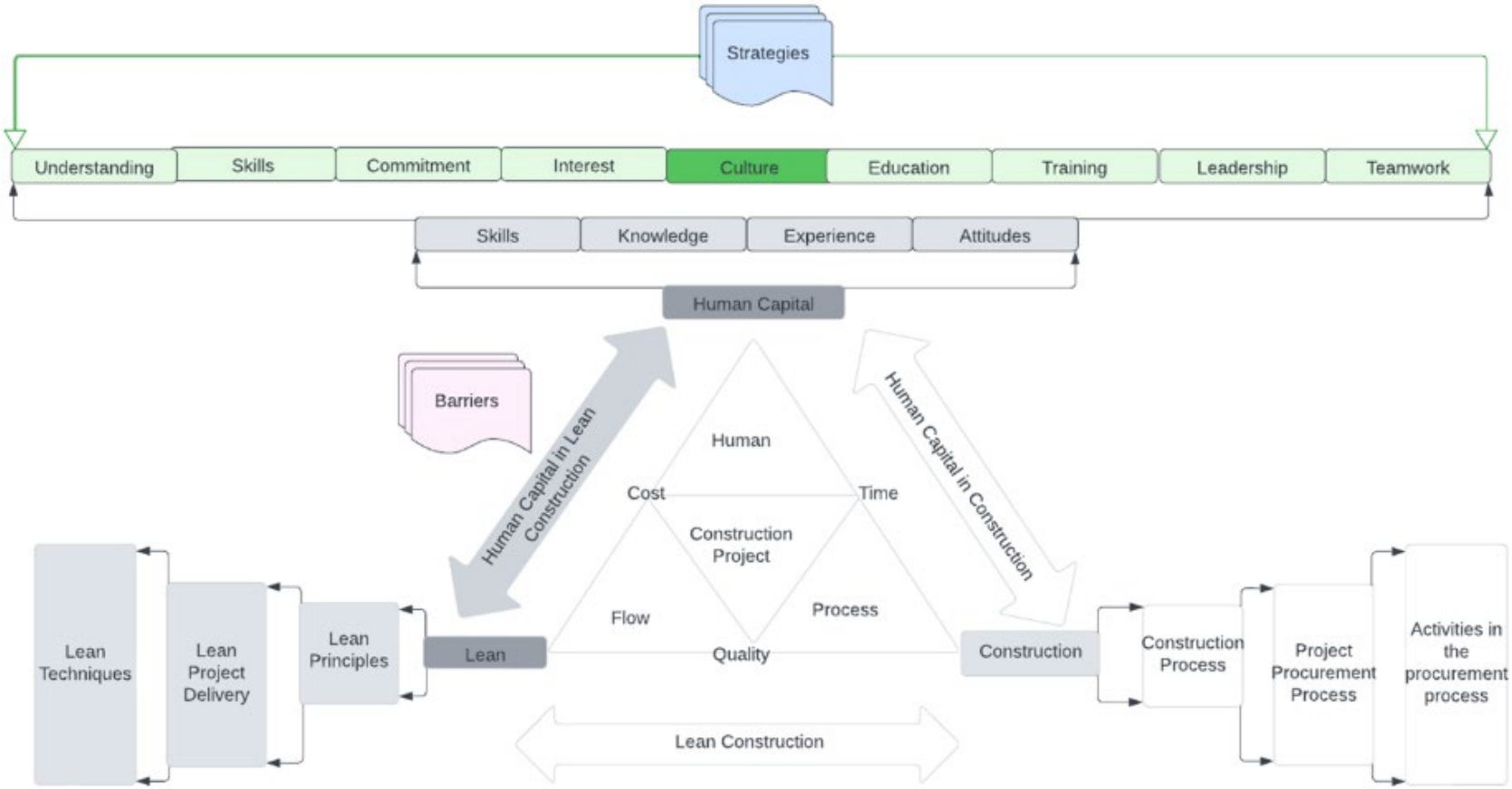

Figure 6-3 Development of the framework - stage 2

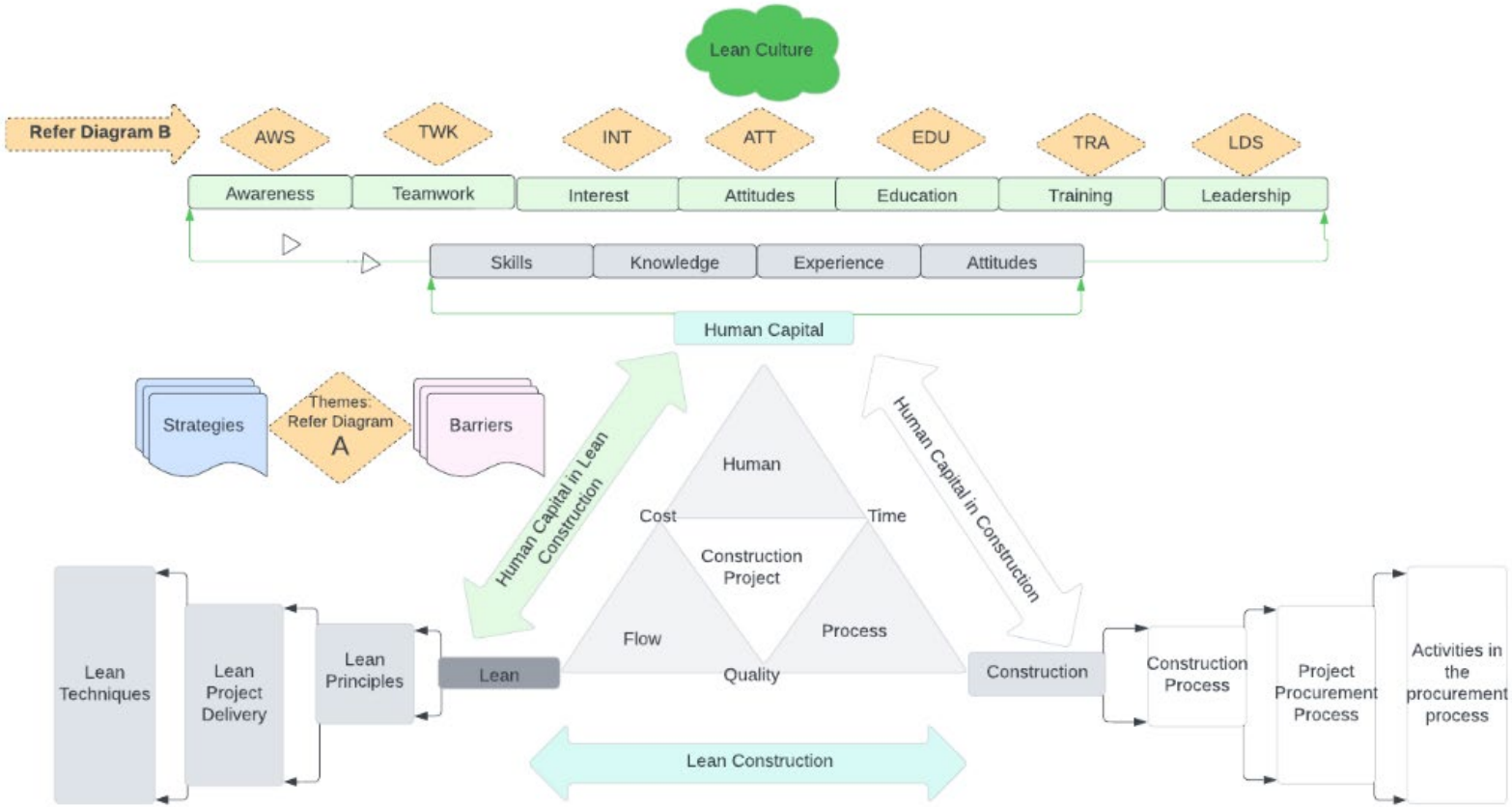

Figure 6-4 Development of the framework -Stage 3

6.2.2 Validation the framework

In section 6.2, the key findings from the primary data were summarized (see figure 6.1), and there are seven themes that emerged from the interview data and the main theme is the Lean Culture. A primary framework was developed based on the primary data and this primary framework was shown to the lean experts to validate it. In the validation, all the themes in the framework were accepted and one new theme 'communication," was accommodated to the framework as described in the data analysis section (see section 5.6). Below table 6.2 illustrates the Experts' opinion on the suggested framework to improve the lean construction implementation from the human capital perspective.

Table 6-2 Validation of the framework

Theme / Keywords	**Opinion**
Lean Culture	All five experts agree to the main theme of the framework to be as *lean culture.* Further they emphasized the significance of people *wearing lean lenses* when they perform their activities to achieve the construction project objectives. Generally, waste means tangible / physical waste, but within the lean culture, the waste refers to "waste of flow activities," which are *non-value adding activities*. Therefore, EO3 and EO5 suggest rewording this to avoid misunderstanding about waste. Also, 'continuous improvement of *the process flow'* was suggested by EO4.
Education	EO3 explained that Lean Education must start from the school curriculums, and essentially in *tertiary education* as a module for all construction related built environment programs. On the other hand, EO stresses that the people who already work in the construction industry including construction professionals, can be educated through practice via *lesson-learned practices*.
Attitude	EO1 and EO4 emphasized that the right attitude plays a major role, and the attitude can be changed through training, awareness, and education. Lean practices and techniques are developed to change the viewpoint, those are not additional or extra activities to consume more cost or time. The subtheme "analysis" had better be changed to represent the viewpoint.
Interest	All suggested that Attitude, culture, and interest are somewhat similar when we look at the examples of the barriers such as "resistance to change, negative attitudes, and cultural barriers within multi-cultural set up.
Culture	EO5 and EO1 suggest that the main theme is lean Culture, and this sub theme is not related to lean culture, and it should be properly differentiated. With the shortage of skilled people, the multi-cultural working set up is very normal, and each culture has a different set of values. This is again related to attitudes,

	and Attitude and culture can be considered as one theme rather two different themes.
Teamwork	*Onboarding* was highlighted by EO3 because the appointment of the best team members is important in implementing lean practices, whereas establishing a *lean mid-set* was proposed by EO5.
Leadership	EO 5 and EO1 discussed introducing a single person responsible for each construction project as a lean leader/ *lean manager* from inception to completion to minimize the non-value adding activities. On the other hand, EO 4 discussed the requirement of a *lean leader*, but how it is different from the existing project manager is a question. Also, EO5 stated the importance of identifying *cluster leaders* for lean implementation.
Training	All experts emphasized the significance of training to *behave and commit* by learning the system and working in a feeling of trust, transparency, and collaboration to eliminate the non-value adding activities, which are waste.
Communication	Communication exists as a new theme within the expert's opinion. Each expert mentioned the lack of communication in implementing lean practices and the strategies to improve communications.

The validated framework is presented below in Figure 6.3. The developed framework comprises the most critical Human Capital barriers in lean Construction Implementation and the most suitable strategies to overcome these barriers. Furthermore, this framework suggests the key themes in developing a Lean Culture to address the human capital related barriers in Lean Construction Implementation in the New Zealand construction industry. Figure 6.5 demonstrates the graphical outline of the framework which links the Lean Principles, Construction Process and Human Capital area. The most critical barriers are separately presented as Part A whereas the most suitable strategies for the New Zealand Construction industry are presented as Part B. These strategies are categorized into eight themes: Attitudes, Awareness, Communication, Education, Interest, Leadership. Teamwork and Training. Section 6.3 presents how these strategies are interpreted in implementing Lean Construction in the New Zealand construction industry.

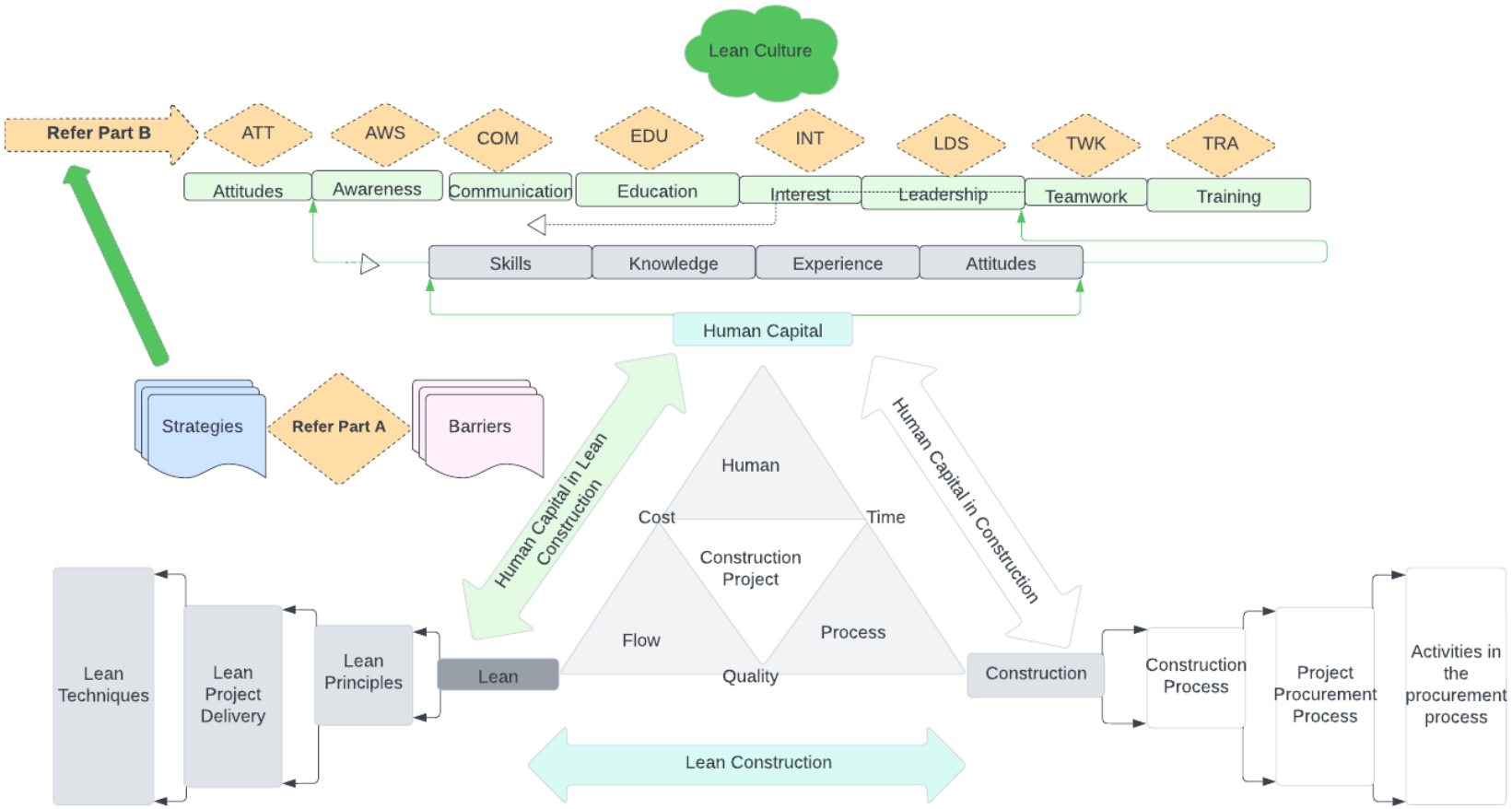

Figure 6-5 The framework to Improve Lean Construction framework from Human Capital Perspective.

Fundamentally, this framework has four main areas. First, the Construction project in the common iron triangle for the fundamental project objectives: cost, time, and quality. There is an output in any industry that contributes to the national economy. The output of the construction industry is a ‘project”. In delivering a project to achieve its objectives, three keywords describe the background of this research: process, flow, and human. The process is the set of activities, then a standard flow of those activities, and the human plays a vital role in carrying out those activities within the flow.

Furthermore, these keywords are extended in the framework as the Construction process, Lean Flow, and Human Capital. The identified gap or the problem of this research is “Human Capital” and the approach to solving the issues of “improving the Lean Construction Implementation” is proposed. When implementing Lean Construction, it is Lean Construction emerged many years ago, but there are barriers. The barriers are critically evaluated, and the most critical barriers are identified within this framework and presented separately as Part A as indicated in the below figure 6.4.

PART A: Most Critical Barriers

Themes	Themes	
ATT	Attitudes	Inaccurate and incomplete work Lack of learning from mistakes/ self-criticism/Group culture, attitudes, and behaviour
AWS	Awareness	Lack of knowledge and understanding of lean practices
COM	Communication	Lack of capabilities (self-criticism, focusing, responsiveness, communication, leadership, commitment)
EDU	Education	Lack of skills & education Inadequate administration of information Resistance to change /Fear of unfamiliar practices /lack of focusing.
INT	Interest	Poor leadership, Lack of support from the top management and Insufficient management skills, and Insufficient management skills
LDS	Leadership	Lack of awareness of lean philosophy
TWK	Teamwork	Lack of commitment / responsive to the team, Low level of integration between Teams
TRA	Training	Lack of training/consulting

Figure 6-6 Most Critical barriers in Lean Construction Implementation from Human Capital perspective

The Human Capital area in the framework was further extended to its definition skills, knowledge, experience, and attitudes. In the literature, Human Capital is described as the "knowledge, skills, and capacities of persons that have economic worth to an organization" (Boohene & Asuinura, 2011). The research findings revealed that the above barriers can be

overcome by implementing suitable strategies. When assessing these strategies, it was revealed that they could be identified into similar themes in evaluating the barriers to Lean Construction Implementation. Overall, all these themes are categorized into 'Lean Culture'. How to build - up this Lean Culture is further discussed, identifying these suitable strategies shown in table 6.5 below and named them in the framework as Part B.

PART B: Strategies

There are three tables 6-3, 6-4, and 6-5 to demonstrate the strategies to improve Lean Construction Implementation from Human capital perspective.

Table 6-3 Strategies for Lean Construction Implementation: Attitudes, Awareness and Communication

Ref	Theme	Strategy	Description of implementation
ATT	Attitudes	Dinner out	The gap between the leaders must be bridged so that the employees could be impacted positively through the lens of the leader's behaviour, which aligns with Lean Culture. This could be having dinner out with the employees selfie with the CEO.
		Selfie with CEO	
		Lean mindset	the companies must communicate the culture upon which the company operates. In other words, every worker in an organization aiming to run Lean Culture must be inducted into the Lean Culture by providing them with every available means of information.
			Highlighting the weaknesses of the traditional methods, Discuss the advantage of lean practices
AWS	Awareness	Engravement of key core values of Lean Culture in peculiar areas	The Lean Culture would gradually be welcomed and practiced by informing the personnel of Lean Construction. One of the ways to get people aware of Lean Construction is to substitute every management stage of construction with Lean Construction approach.
		The constant use of the word "Lean Construction"	The word "lean" must always accompany the word "management" as out of curiosity, many would attempt to find more information about lean management, which ignites the acceptance of Lean Culture. In addition, the core values of Lean Construction can be written at key locations in the construction project in order to frequently reminds the personnel
			tackling unawareness Human Capital-related barrier is cultivating the habit of engraving key concepts of Lean Culture at peculiar places preferably a place of public gathering.
		Relational contracting	In relational contracting, the subcontracting is done with business partners that share similar values with Lean Construction.
COM	Communication	Communication of the company's choice of culture to the workers	developing a model for the progress evaluation of the Lean Construction. In other words, Lean Construction Implementation strategies such as effective communication of the progress of Lean Culture, keeping the employees informed and highlighting the lesson learned so far.
		Big room	Smartboards, video conferencing capabilities to communicate off-site members, meeting notes, and other critical information are readily available in this Big Room for review and discussion

		Relational contracting	In relational contracting, the subcontracting is done with business partners that share similar values with the lean construction.
			The companies have to communicate the culture upon which the company operates. In other words, every worker in an organization aiming to run Lean Culture must be inducted into the Lean Culture by providing them with every available means of information.

Table 6-4 Strategies for Lean Construction Implementation: Education, Interest, and Leadership

Ref	Theme	Strategy	Description of implementation
EDU	Education	Continuous learning process	creating an avenue through which the employees can learn continuously would be productive in educating the employees. This could be by a recurring period of learning, probably in a platform designed for the continuous improvement aspect of Lean Culture. Exposing the employees and stakeholders to information about the green principles and lean principles in management education in the construction industry
		Short course	short courses on Lean Construction targeting the values associated with the effective operation of Lean Culture
		Including lean Construction into the higher education curriculum,	formal education such as diplomas and degrees may be of option for employees with the long-term interest in Lean Construction. The education approach should target inclining the behaviour of the personnel to lean philosophy, in other words, changing the orientation of the personnel should be the primary goal.
		Lean Coaching	A lean coach is an expert in the field of teaching and tutoring people on the concepts of the Lean Culture. Lean coach does not try to prove the learners wrong but rather show them ways to do things much better with advanced positive results for the organization and individuals. So, with the employees already immersed in the Lean Culture unconscious then they can now be exposed to a more former conscious acquisition of knowledge through the help of the lean coach.
INT	Interest	Lean application in each section of construction	Communication of the company's choice of culture to the workers developing a model for the progress evaluation of Lean Construction. In other words, Lean Construction Implementation strategies such as effective communication of the progress of Lean Culture, keeping the employees informed, and highlighting the lesson learned so far.
LDS	Leadership	Planning training and education	leadership training for the stakeholders and employees but with greater attention on the managers, directors, chief executive officer and stakeholders
		Introduce the "Lean Manager" role in the procurement process	the companies have to communicate the culture upon which the operation of the company runs. In other words, every worker in an organization aiming to run Lean Culture must be inducted into the Lean Culture by providing them with every available means of information.
		Relational contracting	In relational contracting, the subcontracting is done with business partners that share similar values with the Lean Construction.

		Technical aspects	The technical aspects involve the empowerment of the employees for the technical aspect of Lean Construction. In addition, the tools must be mastered as well so the employees that will be dedicated to the operation of tools for Lean Construction must be equipped with the necessary knowledge required to run lean construction.
		Tools	

Table 6-5 Strategies for Lean Construction Implementation: Teamwork and Training

Ref	Theme	Strategy	Description of implementation
TWK	Teamwork	Role Model	The team working must flow from the top-ranking personnel down to the least. The chief Executive officer must find a way of building relationships with the management and management to the workers, such as engineers and the trends go on and on. Humility and respect are required from the top-ranking personnel to impact the lower ranks personnel. The management must represent a good role model for the workers.
		Lean managers and cluster managers	the company seeks the expertise in lean managers to manage the operation of Lean Construction for effective recognition of financial advantage or disadvantage the managers exhibiting Lean Culture as by this the employees and other stakeholders may find it easier to blend to the behaviours of their leaders which eventually may reduce the cost of intensive training for the employees
		onboarding	
TRA	Training	Workshops	workshops could be organized for the start to introduce the basic concept of Lean Construction
		Technical aspects	The technical aspects involve the empowerment of the employees for the technical aspect of the Lean Construction. In addition, the tools must be mastered as well so the employees that will be dedicated to the operation of tools for Lean Construction must be equipped with the necessary knowledge required to run lean construction.
		Tools	

6.3 Interpretate the results

The above figure 6.1 shows the key themes identified through the research findings in the middle of the figure. The barriers are presented on the left side of the column, whereas the strategies are presented on the right side of the column in this figure. Figure 6.4 above demonstrates the most critical barriers to lean Construction Implementation by identifying them into eight different themes within Lean Culture. Also, figure 6.5 above illustrates the strategies to overcome these barriers to improve Lean Construction Implementation from Human Capital perspective, identifying these strategies in to same eight themes. Therefore, first, the Lean Culture is discussed in the next section, and then each theme is presented with the discussions of barriers and suitable strategies using the research findings.

6.3.1 Lean Culture

The data suggest that the absence of Lean Culture is a key barrier to improving productivity and efficiency issues in construction activities using Lean Construction practices. According to the participants in the interview, they frequently stated about developing *"Lean Culture"* in light of the solutions to defeat the barriers to Lean Construction. The word 'culture" appears in all the interview transcripts when analyzing the data. Most of the participants stated the "culture" as a barrier, whereas almost all the participants mentioned the word "culture" as a solution to improve lean Construction Implementation. Therefore, developing the Lean Culture became the most significant when analyzing the results from the semi-structured interviews. Furthermore, this statement was validated at the experts' interviews. All experts agreed that Lean Culture needs to be developed from the Human Capital perspective to improve lean Construction practices.

Similarly, the literature proposes that Lean Culture is a culture that embraces learning, focuses on customer satisfaction, and strongly incorporates the continuous improvement of people and products or services (Adu and Opawole, 2019). From this definition, it can be inferred that adopting the Lean Culture places the highest emphasis on the people in the organization and is inclined heavily toward continuous improvement. The personality of an organization is directly related to the organization's culture because the individual directly influences their input to the company in one way or another (Adu and Opawole, 2019). In other words, how people interact and relate can predict how they will get their work done. Hence, the effect of an organization's culture can be negative or positive, depending on its nature (Forbes & Ahmed, 2020). The fact remains that every company is made up of a culture, which could be structured or unstructured. Structured culture is a culture tailored to achieving a purpose that reflects on the company's goods and services (Eric (2022). In contrast, unstructured culture can be an unexpected way of doing things with no specific target. In deploying Lean Construction Implementation, first and foremost, the integration of lean values and lean models is essential to the smooth operation of lean management as they foster the transformation from conventional management to lean management (Assaf and Al-Hejji, 2006).

The discussion on Lean Culture will be incomplete without referencing Toyota Motor Corporation, whose effective operation of Lean Culture achieved great successes such as the Poka Yoke, Gemba Walk, etc. Toyota, when considering its history in the application of Lean

Culture, it has been observed that it did not put the tools for Lean Culture into place first; instead, it majored in the development of people. Liker (2004) stated that first, we need to people before the product. Therefore, it emphasizes the role of the employees and stakeholders in the success. Culture can be defined as a background influence on a person's behavior different from others and is spontaneous in its manifestation (Hofstede et al., 2005). Martins et al. (2015) state that the national culture significantly influences lean management. The country within which a company is established has a culture that has been reported as one of the leading contextual variables that impact the operation of a company (Martins et al., 2015). Trending errors in the implementation of lean management are focusing most on the tools and technology for lean management and not giving cultural influence a substantial view such as human, social, and cultural impact (Martins et al., 2015). Recall that this research aims to develop a viable framework for implementing lean management in construction. Culture is one of the main parameters to be given high consideration because it can control other parameters, such as the attitudes of the personnel toward lean management. It is relevant that the construction industry comprises employees from diverse kinds of backgrounds, and this implies that they would see things from different perspectives (Forbes & Ahmed, 2020). When approaching the problems, it should be noted that the construction industry is non-homogeneous. Implementing Lean Construction should closely align with the set of people that will execute it.

There are eleven different Human capital themes identified within the Lean Culture based on the literature review. The data from semi-structured interviews accepts only seven themes under the Lean Culture as barriers and the other four themes identify as they are fallen under the seven themes and do not stand alone. Furthermore, the data from experts' opinions suggest that a new theme, *communication* under the development of Lean Culture. The figure below shows the selected themes in the framework to improve the Lean Construction Implementation from Human Capital perspective.

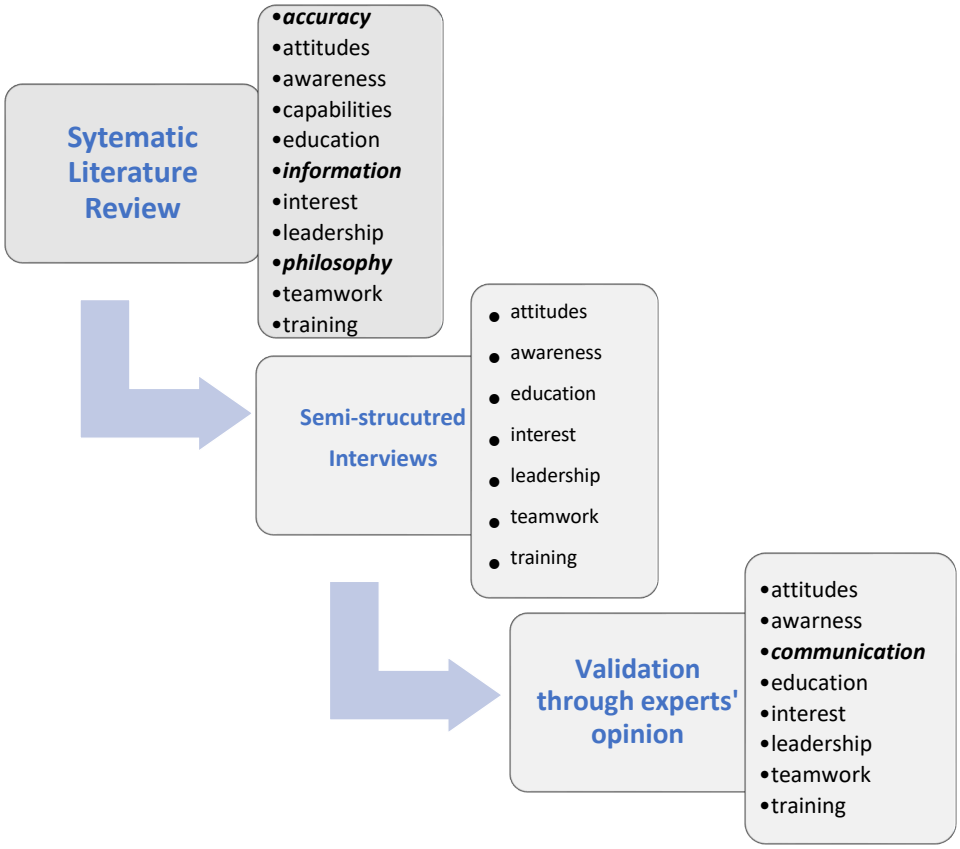

Figure 6-7 Themes in the framework represent the barriers and strategies.

Next, each theme is discussed as a barrier and strategies to overcome these barriers to improve Lean Construction Implementation from a Human Capital perspective.

6.3.2 Attitudes:

Attitudes as a barriers

The data suggests that the attitudes of people working in the construction industry are a barrier to Lean Construction Implementation. In the first category of analyzing data, "attitudes" and "differences" are the two words, and when combined, they give the word "attitude differences. Implementing Lean Construction should closely align with the set of people that will execute it. Moreover, in the findings, the words "lack," "characters," and "divers" are the most occurring. The word "lack" suggests that some employees may lack some characters or attitudes that promote implementing new management systems in the construction industry. This resonates interview data AR04 said that the "*commitment and enthusiasm of the employees seem to be largely dependent on the cultural background influence on their characters*". According to the primary data, QS02 mentioned that "*Resistance to change appears as a norm*

to human nature". Moreover, AR02 said that *'this is why implementing Lean Culture must consider the employees' perspectives and develop a framework for easier acclimatization of the employees to the new culture'. Furthermore, PM01 said that "resistance to change by the employees and stakeholders is also fuelled by the time and commercial pressure".* This is an essential aspect of the Human Capital-related barrier as it resonates with the two pillars of Lean Culture: respect for people and continuous improvement.

Similarly, the literature suggests that the failure of change management because of how people respond and adapt to changes in the system has been one of the main barriers to the effective operation of Lean Culture in construction, according to Jasti and Kodali (2016). Here is the point, the transition from traditional construction methods to Lean Construction is usually missed up as there is always this tendency to apply traditional construction methods as opposed to the new, more effective and quality-oriented Lean Construction methods (Abdullahi et al., 2009). Moreover, the literature supports that lean does not only entail gaining new skills or deploying new technology; it also involves altering people's attitudes and behaviors as well as the corporate culture (Keiser, 2012; Gao and Low, 2014a). Like every other sector, change resistance is among the most well-known idiosyncrasies of the construction industry (Rooke et al., 2004; Rooke et al., 2003; Bejder et al., 2008) from the results obtained from the literature review, through the humility and respect gestures of the top-ranking personnel in an organization (Forbes, 2020). Moreover, the systematic literature review reveals the employees can be impacted, and consequently, their attitudes are altered to the desired attitudes (Mano et al., 2021; Shakil and Rahman, 2019).

Strategies to improve the attitudes.

The data suggests that there are simple strategies which can improve the attitudes of the people work in the construction projects. According to the semi-structured interviews, PM 02 said that giving the employees opportunities to take selfies with the chief executive officer could signal them humility. In addition, PM04 mentioned that *dinner out could be organized whereby all the top-ranking officials are present with the employees, and the opportunity could be used to impact the employees*. The results obtained from the interview also show that lack of attitude is a major Human Capital barrier to successful Lean Culture operation in the construction industry in New Zealand. Therefore, this barrier can be overcome primarily through leadership training for the stakeholders and employees but with greater attention on the managers,

directors, CEO and stakeholders. Combining all these factors described above, it can be inferred that the resistance to change is a function of the employees and stakeholders' attitudes to change in general. The managers and key stakeholders must first practice the deployment of Lean Culture for employees to imitate and this is where the leadership aspect of the Lean Culture comes in for the successful operation of Lean Culture. The leadership of the organization strongly influences an organization's culture and thus the managers must lead the way for the effective operation of Lean Culture. According to the primary data, AR03 and QS01 mentioned that *the gap between the leaders must be bridged so that the employees could be impacted positively through the lens of the leader's behaviour, which aligns with Lean Culture*." Moreover, PM04 and EN01 said that "*this could be having dinner out with the employees, selfie with the CEO". Moreover, PM02 stressed that "the managers could use this medium to discuss Lean Culture and address the pain point".* The below figure 6-12 illustrates the strategies to overcome the barriers as attitudes.

Figure 6-8 Attitudes as a barrier and solutions from primary data

Similarly, literature supports that a desire to participate must be entrenched in the workers attitude (Coffey 2000). Without the desire to be fully involved in the process of Lean Culture, its implementation will be difficult across the organization's hierarchy. While Green (1999) believes that there is a need for top management hegemony in the implementation of Lean Culture, Coffey (2000) insists that there must be a desire to participate in Lean Culture development within the workers.

6.3.3 Awareness

Lack of awareness as a barrier

The awareness as a Human Capital-related barrier was identified in all the research strategies. From the literature review, it was found that one of the key challenges facing the effective implementation of Lean Culture in the construction industry in New Zealand is the lack of information about Lean. In other words, the Lean Culture awareness in New Zealand is very low. This appears to be a vital barrier with high potential, making the imitation of the other barriers easier because it may be difficult to get people along in the pursuit of Lean Culture when the people have no idea about what it is all about. The data support that one of the key challenges facing the effective implementation of Lean Construction in the construction industry in New Zealand is the lack of awareness about Lean. In other words, the Lean Construction awareness in New Zealand is very low, and the structure needs to be improved. EN04 stated that *"we all need to wear the lean lenses from the beginning of the project to see the construction activities through lean lenses".* According to Oxford Dictionary, awareness means getting to know something or being aware of something/information. The awareness as a Human Capital-related barrier was identified in all the research strategies. This appears to be a vital barrier with high potential making the imitation of the other barriers easier because it may be difficult to get people along in the pursuit of operating Lean Culture when the people have no idea about what it is all about.

Similarly, the literature suggests that a lack of awareness of Lean Culture was rampant in the construction industry, and no concrete lean philosophy has been in operation for implementing Lean Culture (Khaba and Bhar, 2017). According to the other literature, the awareness of the Lean Culture must be improved significantly for lean construction to be successful in New Zealand. Similarly, from the systematic review of the selected journals for the current subject matter, it was identified that the operation of Lean Culture would be greatly affected by the lack of awareness about the Lean Construction (Ahmad, 2013). Awareness, one of the key themes from this analysis, stands for keeping the involved personnel aware of important information regarding the Lean Culture for each project to be executed (Sarhan and Fox, 2012).

Strategies to improve awareness.

The interview data analysis shows that many participants believed that unawareness contributes to the ineffective operation of Lean Culture in New Zealand. Although it is a difference between being aware and being educated, the former is the first step toward the latter. So, the deployment of Lean Culture must take root in getting the personnel aware of lean management,

and then the Lean Culture would gradually be welcomed and practiced. The data suggests that one of the ways to get people aware of lean management is to substitute every management stage of construction with Lean Construction approach. In other words, the word “lean” must always accompany the word “management” as by this out of curiosity many would make an attempt to find more information about Lean Construction and that ignites the acceptance of Lean Culture. Therefore, in the framework above, three approaches to solving this challenge are proposed based on the results obtained from the research strategies. Firstly, the companies have to communicate the culture upon which the company operates. In other words, for every worker in an organization aiming to run Lean Culture must be inducted into the Lean Culture by providing them with every available means of information.

Secondly, another approach to tackling unawareness Human Capital-related barriers is cultivating the habit of engraving key concepts of Lean Culture at peculiar places preferably a place of public gathering. So that through multiple encounters with these concepts it may become a part of them, and their behaviours tend to follow the trajectory of the lean concepts. In other words, the already-consumed information in an effortless manner influences their thinking and deeds towards their responsibilities. Thirdly, another key approach to mitigating the effect of unawareness is the inclusion of “lean” in every management word in the organization. This is also similar in effect to the second approach because by the time each worker learns to use “Lean Construction” in every of their conversation, by default their subconscious mind is programmed by the concept of lean and whenever they could learn further about lean, they would approach the learning with a curious mind. This barrier is highly essential to solving other barriers related to Human Capital. The below figure 6-13 demonstrates the strategies to overcome the awareness as a barrier to Lean Construction Implementation.

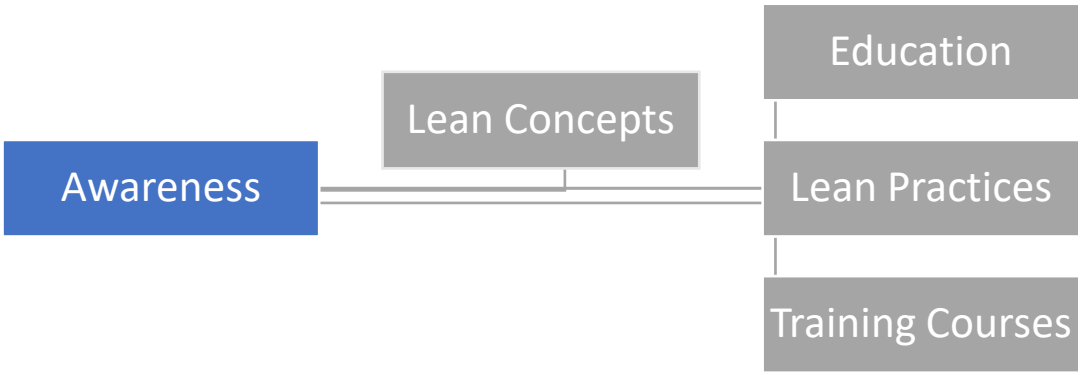

Figure 6-9: Awareness as a barrier and solutions

From the literature review, it was found that lack of awareness of Lean Culture was rampant in the construction industry and no concrete lean philosophy have been in operation for implementing Lean Culture (Khaba and Bhar, 2017). According to the other literature, the awareness of the Lean Culture has to be improved significantly for the lean construction to be successful in New Zealand. Similarly, from the systematic review of the selected journals for the current subject matter it was identified that the operation of Lean Culture would be greatly affected by the lack of information of the involved people (Ahmad, 2013).

6.3.4 Communication

Lack of communication as a barrier

The data obtained from the expert opinions suggests that communication is a major factor for the effective operation of Lean Culture in the construction industry. In other words, they identified *"communication"* as the main lapse in implementing Lean Culture in construction communication is included in the framework after the expert opinion interviews. Moreover, the semi-structured interview data suggests that lack of information is a barrier. PM 01 said that the *"information channel needs improvements"*. Also, QS03 mentioned that *information about the lean practices are limited and it is the top leader's responsibility to transfer to the workers"*. Therefore, it is evident that communication is a barrier to Lean Construction Implementation. Similarly, the literature informs that the lack of management commitment, the fragmented and cyclic nature of the construction project, and unavailing communication between all project participants are the barriers to implementing Lean Construction (Shakil and Rahman 2019).

Strategies to improve communication.

The data obtained from experts supports improving communication by improving awareness, attitudes, and interest. The Big Room or Obeya in Japanese, is a major tool for improving effective and timely communication in construction projects (Forbes & Ahmed, 2020). It is a physical space that brings together different project team members and promotes cross-cultural collaboration. Further, they emphasize Big Room on a construction site is an investment. Smartboards, video conferencing capabilities to communicate off-site members, meeting notes, and other critical information are readily available in this Big Room for review and discussion. The below figure 6-14 illustrates the big room concept.

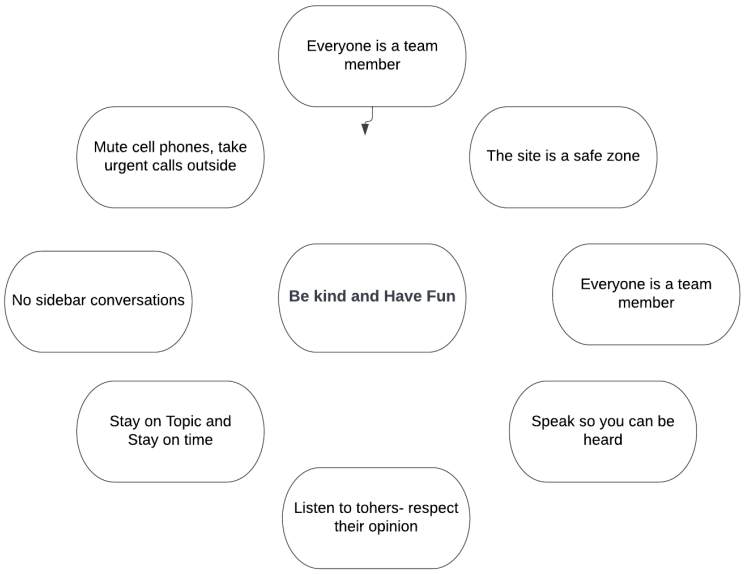

Figure 6-10: Big Room Rules adopted from Forbes & Ahmed (2020)

Establishing Lean Culture often requires tabling difficult conversations, and this is because for Lean Culture to be influential in operation, the facts associated with it must comply with; otherwise, you do not have Lean Culture. Participating in critical conversations cannot be avoided in Lean Culture creation. For instance, a difficult conversation could be someone not meeting their commitments to the organization, such as being absent in the meetings where their contributions are highly needed for the achievement of the goal of a project(Forbes & Ahmed, 2020). Therefore, communicating information to these people requires experience and wisdom for communication to be achieved. According to Hagan (2016), effective communication must be honest, respectful, and timely to create Lean Culture. It must be noted that the absence of one render communication unproductive.

6.3.5 Education

Lack of education as barrier

The data analysis identifies the word "education/educate," which has made the most occurring theme, and analyzing it should give a clue on implementing Lean Construction via education. Education as a barrier to the implementation of Lean Culture centers around the immersion of the employees in the knowledge of lean through former or informer education. Education can be done in a way that the employees are released into the hands of experts to expose them to the key information that sustains the operation of Lean Culture in an organization. The data supports that there is limited education among the employees that work in the construction industry. The view of the participants on the education approach to integrating Lean Culture suggests that they are positive about the impacts of education on the effective operation of Lean Culture. The education part of Lean Construction fosters the circulation of Lean Culture in the construction industry.

Strategies to improve education.

The data suggests four strategies to overcome the challenges associated with a lack of education, as indicated in figure 6.11 below.

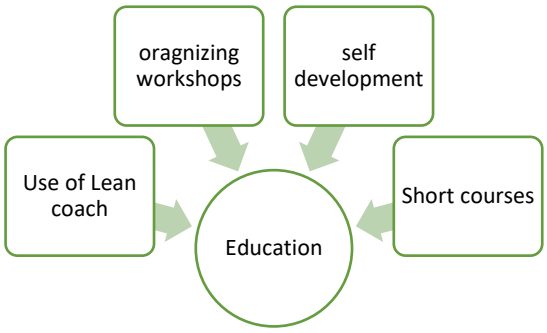

Figure 6-11 Strategies to overcome the education as a barrier.

Firstly, according to PM03 '*use of lean coach may be appropriate'* when the employees are already aware of lean basics through the approaches discussed earlier in awareness, teamwork, and leadership barriers. Moreover, EO 2 mentioned that '*lean coach does not try to prove the learners wrong'* Secondly, most of the participants agreed that organizing workshops whereby the concepts of Lean Culture are discussed can be helpful as well in educating employees about Lean Culture. Thirdly, EN04, PM02, and QS03 mentioned that *encouraging employees to engage in self-development may be a good path to educate them indirectly*. So, creating an

avenue through which the employees can learn on a continuous basis would be productive to educate the employees. This could be by a recurring period of learning, probably in a platform designed for the continuous improvement aspect of Lean Culture. Lastly, the education in the concept could mean former education, such as attending a college or an institute to study Lean Construction in construction or offering short courses on Lean Construction. For instance, workshops could be organized for a start to introduce the basic concept of Lean Construction. Also, short courses on Lean Construction target the values associated with the effective implementation of Lean Culture. The education approach should target inclining the behaviour of the personnel to lean philosophy; in other words, changing the orientation of the personnel should be the primary goal.

Similarly, the literature reveals that a lean coach is an expert in the field of teaching and tutoring people on the concepts of Lean Culture (Forbes & Ahmed, 2020). But rather show them ways to do things much better with advanced positive results for the organization and individuals (Aij et al., 2015). So, with the employees already immersed in the Lean Culture unconscious then, they can now be exposed to a more formerly conscious acquisition of knowledge through the help of the lean coach (Forbes, 2020). As a pillar of Lean Culture, "continuous improvement" is essential to sustainable Lean Culture (Kumara et al., 2022). This starts with leadership education, which is fundamental to adopting Lean Culture (Romero et al., 2019).

6.3.6 Interest

Lack of interest as a barrier

The data suggest that the lack of interest from the employees and management is a barrier to implementing Lean Construction, this has to do with also the lack of awareness whereby the advantages associated with Lean Culture are not known to the management, let alone the employees. Then, the lack of interest must be provided with means of mitigating it. Three (3) approaches are proposed in this research as regards ways to mitigate the lack of interest in Lean Culture in the construction industry in New Zealand. Firstly, the application of Lean Culture in each section of a construction company must be identified. When this is placed into place, then targeting the set of people to carry out the implementation may become easy. Secondly, educating the employees on the disadvantages and drawbacks of traditional construction methods would be a great choice. Enlightening the employees while the switch to Lean Culture

is better could open employees' minds to learning. Thirdly, the advantages and the ways through which the successful operation of Lean Culture could impact the growth of the company must be explained to the employees. The goal is to create an inner-driven force for the employees to surrender to learning Lean Culture and embracing the change that it brings to them.

The personnel have an interest in Lean Construction which eventually would lead to the acceptance of Lean Culture, which is another key factor to be considered in developing a framework for implementing Lean Construction. It is imperative to search for the level of interest of the personnel in lean management before the implementation because if there is curiosity, it would be more accessible to pass across the message of Lean Culture, and the acceptance probability seems higher (Engebo et al., 2017). First, having an interest in Lean Construction comes from prior knowledge of the concept. It probably intrigues the personnel to want to explore the concept by wanting to learn more and practice. For instance, the exciting part of the factors could be that personnel find an aspect of Lean Construction interesting, such as the application to their field, which could benefit their career in the long run. Nevertheless, what about the case of personnel having no interest in Lean Culture? How could this be handled because this is what is applicable in the real world? This still boils down to the awareness of the personnel of the nitty-gritty of Lean Construction and how this applies to the different sections of a construction project. For instance, the application of Lean Culture in the quantity surveyor could be a friendly cost estimation presented to the clients that depict high consideration and customer satisfaction orientation. In addition, structural engineers could later be interested in Lean Culture when they observe the correlation between Lean Culture and significant improvement in their functions in their respective projects.

Strategies to improve the interest.

Therefore, the data suggest that handling the personnel's interest would be: disintegrating Lean Culture by sectors and stating the role of Lean Culture in each sector. On the part of the lack of interest from the employees and management, this has to do with also the lack of awareness whereby the advantages associated with Lean Culture are not being known to the management, let alone the employees. Then, it is important that the lack of interest is provided with means of mitigating it. Similarly, Li et al. (2020) believe that the willingness to adopt the implementation intention: Enterprise size & ownership, Information level, Knowledge,

Organizational structure & culture, and market factors contribute immensely to the Lean Construction success.

6.3.7 Leadership

Lack of leadership as a barrier

The data suggest that the lack of leadership is a key barrier to implementing lean Construction. PM03 stated that "there should be a separate manager to look after the lean aspect of the project". All participants at the semi-structured interviews agreed that leadership can play a vital role in improving Lean Construction Implementation. Moreover, the data from experts support; EO 5 and EO1 discussed introducing a single person responsible for each construction project as a lean leader/ lean manager from inception to completion to minimize the non-value adding activities. Moreover, EO5 stated the importance of identifying cluster leaders for lean implementation. Similarly, the literature suggests that leadership barriers are difficulty getting support and commitment from top management, resistance to change by the leadership, centralization of decisions and the challenge of establishing participatory (Mano et al,. 2021),

Strategies to improve the leadership.

Analyzing the contents of the code, it can be observed that project monitoring is one of the keywords the participants mentioned as the primary strategy for tackling Human Capital barriers in the construction project. There are words like "tools," "improper," "resources," "design," and so forth. This suggests that project management could be regarding resources management, design management, etc. Therefore, implementing Lean Construction should provide a framework that considers lapses associated with project management in construction projects. This could be in the form of having lean managers for the projects. In the case of Lean Coaching, which is a crucial strategy for the effective operation of Lean Culture, the communication must be done honestly, respectfully, and timely so that new beliefs and behaviours can be received. The change from conventional construction methods to Lean Construction can be executed through the assistance of an impartial third party, also called a facilitator (or lean coach). Hence, through Lean Coaching, communication can be improved, and the employees and stakeholders can be educated.

Lean Manager: A factor that the participants have flagged as negative is "complexity, " which includes complexity in any form, such as construction complexity, system complexity, and

stakeholders' complexity. These pose challenges to the implementation of Lean Construction and, of course, constraints to Lean Culture adaptation in the construction industry. Each complexity is attached to different construction sections; therefore, the approach to overcoming them will be sectionally dependent. However, the generality of the Lean Culture would reduce the significance of the differences in the approach to overcoming these complexities (Soliman et al., 2018). Construction complexity could be related to the architectural design and the associated discrepancies, while stakeholder complexity could be related to leadership. The construction complexity can be overcome through the disintegration of the stages of the project to effectively monitor the stages and the associated discrepancies. Project management is a broad concept that involves applying many processes and systematically implementing knowledge, skills, and tools to deliver the project within the planned constraints (Heagney, 2016). In other words, project management can be defined as a process of leading a project through each phase to achieve the project's aim and objectives within a given time and resources (Heagney, 2016). Project management has been considered one of the most crucial success factors in construction projects (Walker, 2015). Project management involves many activities that still boil down to the Human Capital factor, such that deficiency in Human Capital leads to a barrier. In contrast, adequate Human Capital, such as skilled personnel in project management, leads to a positive impact.

The stakeholder complexity can be overcome through teamworking by defining the role of each stakeholder. Project management is a broad concept that involves applying many processes and systematically implementing knowledge, skills, and tools to deliver the project within the planned constraints (Heagney, 2016). In other words, project management can be defined as a process of leading a project through each phase to achieve the project's aim and objectives within a given time and resources (Heagney, 2016). Project management has been considered one of the essential success factors in construction projects (Walker, 2015). Project management involves many activities that still boil down to the Human Capital factor, such that deficiency in Human Capital leads to a barrier. In contrast, adequate Human Capital, such as skilled personnel in project management, leads to a positive impact.

In the case of complexity and challenges related to project management in construction projects, the application of Lean Construction through a lean manager could be used. A Lean manager is an equivalent of a traditional project manager but operates on the principles of Lean

Culture. A lean manager is an employee in an organization that operates Lean Construction. Such an employee oversees the effective operation of lean management, develops new tactics for improving Lean Construction, and manages the system with long-term benefits to the organization. In general, the responsibility of a lean manager varies by organization; however, a lean manager ensures that complexities in the system are managed in a way that the effect on the operation of Lean Construction is controlled. In this section of the data analysis and findings, the results obtained from the literature and the interview data will be comparatively studied to see the correlation between the results to further reinforce the factors with a stronger influence on the operation of Lean Culture and to stress emphasis on the newly discovered factors influencing the operation of Lean Culture in the construction industry.

The rapid growth of urbanization and global economic growth coupled with the increasing population across the globe has caused increasing demands for different kinds of infrastructure with different purposes. A lot of challenges have surrounded the construction sector in the past few decades and have caused the productivity of the construction sector to decline significantly. These challenges can be related to various factors such as mismanagement, lack of innovation, substandard quality, excessive rework, resource, and time overruns (Khaba and Bhar, 2015). Therefore, new approaches to solve these challenges must be deployed to improve the production level rapidly. Operational improvement can be significantly achieved by applying Lean Construction. Primarily, Lean Culture can improve quality and enhance productivity in the construction sector. Lean construction has been defined as improving processes and products based on the construction industry's requirements by effectively eliminating waste (AlSehaimi et al., 2014).

6.3.8 Teamwork

Lack of teamwork as a barrier

The data reveals the importance of the teamwork, and they recognized that as a barrier. QS 05 said that *"...maybe of lack of cooperation of the employees and inadequate teamwork."* Also, EN03 and PM03 mentioned that *"in construction, we do not have individual goals" and "we need to work as a team to achieve the project goals, but unfortunately, some professionals do not think so."* In other words, teamwork still boils down to the attitude/behaviour of the team members, which implies that teamwork is impossible without a pattern of behaviour; there has

to be a way of interaction that fosters teamwork. Fundamentally, the application of Lean Culture closely relies on the attitude/behaviour of the team members in the construction project; therefore, the framework for Lean Construction Implementation must be inclined to the attitude of the group's team members.

Similarly, the literature supports that teamwork in construction can be defined as gathering a group of high-skilled personnel from various backgrounds and expertise to achieve a common goal (Adu and Opawole, 2019). In construction, teamwork is a very vital factor for the success of a project, and this could involve communication from one personnel to another or the passing of information from one personnel to another for the success of a project. The probability that a change in a system will survive is proportional to the degree of acceptance and loyalty by an organization's leadership and the system's continuous improvement (Kaufman, 2022). In the construction industry, improving project performance has prompted the need for a different view on effective teamwork among personnel and stakeholders (Adu and Opawole, 2019). The point is that cohesiveness has to be achieved for Lean Culture to be influential, i.e., eliminating waste, quality improvement, and innovation creation are all functions of teamwork (Kaufman, 2022). Belbin (1993) has related teamwork with the pattern of behaviour of the personnel that enables interaction with each other for productivity.

Strategies to improve the teamwork.

It is an excellent choice to focus on how the personnel from different teams will work together to achieve a common goal of delivering a project with high customer satisfaction and continuous improvement. People who make up a company are the number one factor enabling a culture's operation. Some consider culture as a collection of life experiences brought to an organization by each employee. The impacts of each member of an organization are substantial on the organization's culture; however, it is most influenced by the organization's founders, executives, and key stakeholders. This implies that this set of people got to work together to achieve the organization's purpose.

Fundamentally, the application of Lean Culture closely relies on the attitude/behaviour of the team members in the construction project; therefore, the framework for Lean Construction Implementation must be inclined to the attitude of the group's team members. Firstly**,** Teamwork is a Human Capital-related barrier that has been identified from all three research

strategies. There is link between the acceptance of change and the level of cooperation within different sections of an organization. It is upon this link that the teamwork Human Capital-related barrier surfaced. It was observed that an organization with strong teamwork tends to find it easier to introduce new things and the workers tend to acclimatize quicker than the organization with weak teamwork. This is because when a part of an organization embraces the change, the other parts have no option but to blend as the interrelated work culture enables the flow of information.

Teamwork is required among the Director General Management, Engineers (of all types), Quantity Surveyors, Project Managers, and Product Manager. Teamworking must flow from the top-ranking personnel down to the least. The chief executive officer must find a way of building relationships with the management and management to the workers, such as engineers, and the trends go on and on. Humility and respect are required from the top-ranking personnel to impact the lower ranks personnel. The management must represent a good role model for the workers. The engineers and quantity surveyors must collaborate in delivering their duties to achieve Lean Construction. If respect for colleagues is lacking within the organization, it would be difficult to respect customers. Both the project manager and product manager can be substituted with a lean manager. Lean manager is an expert in lean construction equipped with the necessary skills to manage the effective operation of Lean Culture in an organization. Alternatively, both the project manager and product manager can report to the lean manager to ensure that their moves align with the Lean Culture goal.

In the construction industry, improving project performance has prompted the need for a different view on effective teamwork among personnel and stakeholders (Adu and Opawole, 2019). The point is that cohesiveness has to be achieved for Lean Culture to be influential, i.e., eliminating waste, quality improvement, and innovation creation are all functions of teamwork (Kaufman, 2022). Belbin (1993) has related teamwork with the pattern of behaviour of the personnel that enables interaction with each other for productivity. In other words, teamwork still boils down to the attitude/behaviour of the team members, which implies that teamwork is impossible without a pattern of behaviour; there has to be a way of interaction that fosters teamwork.

6.3.9 Training

Lack of training as a barrier

The data suggest that training is one of the key Human Capital-related barriers to the implementation of Lean Culture. From the interview data, the word "Training" has frequently been identified in construction projects which sometimes could last days, months, or even years, the act of training the employees are usual occurrences. Training could relate to any part of the project, such as safety, management, security, etc. The code's content description can be seen by the arrangement of the words that make up the code. In the first category, the words "training" and "employees" are grouped, which intuitively suggests the training of the employees in construction projects.*PM03 talked about the lack of "work-ready training,"* and *AR04, EN03, and QS05 believe "less industry connection to training". Moreover,* PM02 stressed that *"there is a limited supply of trainers".* Similarly, the literature supports there is a lack of training to implement lean Construction (Alarcon et al., 2005: Shakil and Rahman, 2019). New Zealand Construction Industry Survey 2021 highlights that one of the key challenges in the New Zealand Construction industry is high cost of training, limited supply of trainers, and lack of support for work-ready training and industry induction.

Strategies to improve the training.

The primary data suggests that *"training should be in the construction schedule",* " *on the job training is recommended", "training on various available tools is required",* " *Technical aspects of the training will help workers to arm with Lean Construction Implementation", " allocating sufficient budgets is important"* Training was recognized as an essential part of the construction processes, and all participants suggested the word "workshops" and "technical aspect" in training. The training aspect is primarily focused on two approaches: technical and tools. The technical aspects involve the empowerment of the employees for the technical aspect of Lean Construction. In addition, the tools must be mastered, so it is important that the employees dedicated to the operation of tools for lean construction are equipped with the knowledge required to run lean construction. Having personnel with the required skills in lean management is a challenge in implementing Lean Culture.

Similarly, the literature supports that these strategies are viable and significance. One of the main factors contributing to the failure of many Lean Construction conversions is the excessive attention to the tools and technology needed to run the system (Pekuri et al., 2012). This has

undoubtedly always cut short the high expectations of lean management; it would not just measure up to the expected results (Pekuri et al., 2012). Failure to understand the philosophy behind the Lean Culture and the view of an involved set of people might be a stumbling block to the effective implementation of Lean Culture. According to Pekuri et al. (2012), people's motivation towards acquiring social skills is an excellent approach to having personnel with a receptive heart to learn about culture. Lean Construction primarily focuses on customer satisfaction and constant improvement on the part of the personnel. One of the main approaches to effectively implementing the Lean Culture is to focus on the recruitment of the personnel, such as looking out for social skills so that through training and education, they can be improved, which spontaneously enables the long-term acceptance of Lean Culture.

The research question of this study emerged as how to improve Lean Construction Implementation from a Human Capital perspective. The aim was to develop a framework to improve Lean Construction Implementation from the Human Capital perspective. Four objectives and eight sub-research questions were identified (see section 1.3), and the following table illustrates how each methodology was utilized to achieve the objectives.

6.4 Achieving the objectives

This research aimed to develop a framework for improving Lean Construction Implementation from Human Capital perspective and four objectives were identified to achieve the aim. The below Table 6-6 shows how these objectives are achieved using different research methodologies to answer the key research question.

Table 6-6 Objectives, Research Question, and Methodologies

Objectives	RQ: How to improve Lean Construction Implementation from Human Capital Perspective?	Achieved by			
		Semi-structured 24 interviews	Detailed Literature Review	Systematic Literature Review	Expert opinion
Objective 1: To identify the barriers to Lean Construction Implementation	What factors affect the implementation of Lean Construction? What are the barriers to implementing Lean Construction? How are these barriers related to the Human Capital perspective?	✓ ✓	✓ ✓ ✓	✓ ✓	
Objective 2: To assess the Human Capital-related barriers to lean construction implementation	How to define Human Capital in Lean Construction Implementation? How to evaluate the barriers in Lean Construction Implementation from a Human Capital perspective? What are the most critical barriers in Lean Construction Implementation from a Human Capital perspective?	✓	✓ ✓	✓ ✓	✓
Objective 3: To evaluate the strategies for improving lean construction implementation	What are the widely suggested strategies to overcome Human Capital barriers in Lean Construction Implementation?	✓ ✓		✓ ✓	✓
Objective 4: To develop the framework for addressing the Human Capital related barriers	What are the most suitable strategies to improve Lean Construction Implementation from Human Capital perspective?	✓		✓	✓

This research focuses on the Human Capital barriers, and this is because Human Capital barriers have been the primary drawback for the effective operation of Lean Culture in the construction industry in New Zealand. The skills and tools can be taught but the effectiveness of Lean Culture lies mostly on the behaviours of the employees. Remember that Lean Culture is a waste reduction-driven management approach (Womack & Jones, 1996) , and this reduction can only be achieved through the collaboration of each member of the organization as they contribute in one way or the other to the success, productivity, and efficiency of each project(Forbes & Ahmed, 2020). A company can go ahead to buy all the necessary tools for the implementation of Lean Culture, but if the employees and stakeholders are still with the old mindset of conventional construction methods, the Lean Culture will strive to operate successfully. Thus, for the effective transformation to take place from the conventional construction methods into Lean Construction, then the culture of the organization has to be revisited.

Culture is not as complicated as it may sound in this context, but it is as powerful as it is simple for the transformation of an organization. With adequate control over culture, significant improvement can be attained in the ways things are done in an organization. Since the beginning of the concept of "lean" one main thing that is common to every form of lean is the two pillars that hold the concept: (1) respect for people, and (2) continuous improvement. In other words, in the implementation of Lean Culture, the principles of the two pillars must be conserved. For instance, a construction company operating Lean Culture must have employees who respect one another and are open to continuous improvement. Jettison these principles, then you are not operating Lean Culture!

The transition from conventional construction into Lean Construction through the effective operation of Lean Culture is not an easy task and it requires right collaboration from the most important set of personnel in an organization. According to Achanga et al. (2006), how successful lean manufacturing would be predicted by four primary factors which are: (1) leadership together with management; finance; skills and expertise; and an organizational culture that embraces the key pillars of lean which are respect for people and continuous improvement.

Hence, this work focuses on the development of a framework for the implementation of Lean Culture by systematically combining many analysis approaches such as the use of literature review, systematic review, and interview which serves as the primary data source. Both the literature review and systematic review enable us to infer information from the earlier works on the subject matter through which the interview questions were framed. Therefore, in this case we shall be performing juxtaposition on the approaches to discuss the objectives of the research which are three (3) in numbers as stated below.

1. To identify the **barriers** to Lean Construction Implementation in the construction industry.
2. To assess the **Human Capital-related barriers** in Lean Construction Implementation in the construction industry.
3. To evaluate the **strategies** for improving Lean Construction Implementation in the construction industry from the Human Capital perspective.
4. To develop **the framework** for addressing the Human Capital related barriers in Lean Construction Implementation.

Objective one

From the literature review, various barriers to the implementation of Lean Construction have been identified. According to Adegbembo et al. (2016), a lack of interest among construction parties to sit for a weekly review meeting to solve the problems causing project plan failures has been a barrier to implementing Lean Construction. From this, we can infer a few factors that could be responsible for this barrier: (1) lack of leadership, and (2) lack of interest in Lean Culture. According to the systematic review and the results obtained from the interview data analysis in this research, lack of leadership and lack of interest are among the top barriers being identified against the successful implementation of Lean Culture in New Zealand. Senior management is critical to benefiting from Lean Construction and implementing a successful strategy. Higher management must devote enough time and money to developing an efficient plan to update management and incorporate fresh Lean Construction ideas. However, according to investigations by Enshassi et al. (2021), a major barrier to advancing the goals of Lean Construction is top management's failure to exert true leadership. Contrarily, middle management, instead of the upper ranks of corporations, is where the most significant barrier is located, according to (Aslam et al., 2020).

Lean Culture transformation relies strongly on the organization's leadership as they have to lead the way for others to follow. Honestly, the unavailability of true leadership that believes in Lean Culture and its benefits would discourage employees due to the lack of motivation from the leaders. Lean Culture cannot be engineered, nor can it be paid for on the counter rather it is a process through the conscious effort of controlling behaviours and doing things in the organization. In other words, the effective implementation of Lean Culture has potential to uttering how we think as a team, talk to one another and customers, and act and react to every critique. It is more or less like changing/working on the minds and hearts of the people; this would be impossible without effective leadership. The fundamental definition of leadership states that a leaders direct and lead people to achieve a common goal, and in this case refer to leaders that direct and lead people to achieving Lean Culture through the unanimous contribution of every member of the organization. In the process of lean transformation, the leadership aspect of the process is usually assigned to the senior managers but unfortunately, many of these managers treat Lean Culture more on the basis of the tools and not on the human barriers. And this consequently results in the lack of interest of the involved group of people. Interest can be defined as a state of wanting to know something or desiring to learn something (Oxford Dictionary).

In other words, interest can be referred to as an inner force propelling someone to want to learn a thing. For instance, when someone has an interest in a particular process or activity, you may not have to compel such a person to carry out whatever their responsibilities are (Aristizábal-Monsalve et al., 2022). Hence, the employees' lack of interest may result from the lack of leadership to lead the way. These two barriers foster the rest of the barriers to penetrating into the organization, such as the change of mindset and behaviour, lack of training, lack of teamwork, etc. Come to think of it, leadership that does not believe in Lean Culture would not support the empowerment of its employees, such as giving them the training and education required for the successful operation of Lean Culture. So, in this research, we have identified many barriers to implementing Lean Construction in New Zealand, and most especially, we were able to associate many of the other barriers to the lack of leadership, which give birth to a lack of interest in the employees.

Objective two

The second objective is to assess the Human Capital-related barriers in Lean Construction Implementation in construction projects, and the third objective is to propose suitable strategies to overcome these barriers. As earlier stated, there are many barriers to the implementation of Lean Culture in the construction industry but the one this research aimed to study is the Human Capital-related barriers, in other words, we studied the barriers that are more related to human factors in construction industry in New Zealand. From the literature review (Albalkhy & Sweis, 2021; Enshassi et al., 2021; Mano et al., 2021), several barriers related to the human factors were obtained and this includes education-related concerns, lack of dedication and backing from the top management, lack of customer focus, insufficient lean knowledge and comprehension, change resistance in the management, issues with culture and human attitudes, inadequate preparation for quality, absence of long-term thinking and planning, poor management and lack of leadership abilities and so forth. From these barriers, a few keywords such as knowledge, leadership, management, cultural background, and attitudes can be deduced. This implies that the challenges facing the successful implementation of Lean Culture according to the results obtained from the literature can be linked to any of these keywords. Insufficient knowledge of or comprehension of lean principles "Notions from manufacturing lean thinking are being applied to the construction industry (Eriksson, 2009). As a result, many perspectives on Lean Construction are directly tied to lean manufacturing. There is contention concerning how lean methods should be used in Lean Construction. (Aristizábal-Monsalve et al., 2022). Since some lean production techniques may not widely apply in the construction industry, its users in the construction sector must modify and adapt the concept to suit the construction sector.

Overall, it was found that Lean Construction education is limited to tertiary education and Lean is not included in the school curriculum. Most of the concerns stemmed from the assessment of competency gaps and the curriculum design when contrasted to the particular construction management education per se (Mohammad et al., 2019). In terms of the culture and attitudes of the people involved, it has to be established that lean does not only entail gaining new skills or deploying new technology; it also involves altering people's attitudes and behaviours as well as the corporate culture (Keiser, 2012; Gao and Low, 2014a). Like every other sector, change resistance is among the most well-known idiosyncrasies of the construction industry (Rooke et al., 2004; Rooke et al., 2003; Bejder et al., 2008).

Interestingly, from the systematic review results, some of the keywords deduced from the literature review emerged as the Human Capital-related barriers to the implementation of Lean Construction in New Zealand. Out of the ten primary journals that focused on the subject matter, eleven (11) Human Capital-related barriers were identified, and these are awareness, training, capabilities, interest, attitudes, philosophy, teamwork, leadership, information, errors and omissions, and education. Out of these barriers, five (5) of them (awareness, training, capabilities/knowledge, interest, and attitudes) were found in all the ten (10) journals used for the systematic review and even in other journals. The biggest obstacle to lean deployment was a lack of appropriate lean awareness and comprehension. The next highest listed impediments to lean adoption were lack of technical capability, lack of financial resources, and reluctance to cultural change. The national and organizational culture influences the effective operation of Lean Construction (Khanh and Kim, 2016). The transition from traditional construction methods to Lean Construction requires committed leadership that can lead the way by motivating the employees through the change process (Khaba and Bhar, 2016). The cultural difference relates to all forms of differences, such as geographical and cultural differences among the team members of an organization.

The construction industry is an industry with diverse kinds of people with different backgrounds. Lean construction and Lean Culture require primarily carrying everyone along in achieving the organization's goal. Because the people have different cultural backgrounds, lean construction has to be implemented so that a common ground is reached in the aspect of organizational culture. Creating a Lean Culture simply means calling the attention of everyone to waste and the removal of this waste in the system. Lean Culture requires self-assessment in whatever each team member does; this means the employee follows the facts of a matter than their own opinion. Hence, they are considered essential human-related barriers to implementing Lean Culture. When compared with the results obtained from the literature review, they are similar, and it connotes the importance of these barriers to the successful implementation of Lean Culture in the construction industry in New Zealand.

Objective three and four

Lastly, from the interview data analysis, several Human Capital-related barriers were also identified from the participant's responses to the survey questions. Namely: awareness, culture, management/leadership, education, training, experience/knowledge, interest, skills,

complexity, and teamwork. From the analysis, the management emerged as the barrier with the highest frequency, and it also implies the lack of leadership in the construction industry in New Zealand. When the results from the literature review, systematic reviews, and interview analysis are compared, we can infer some barriers that are very common to the implementation of Lean Culture and the ones peculiar to the present project. Nevertheless, we have found a strong relationship between leadership as a barrier to implementing Lean Culture and the effective operation of Lean Culture in the construction industry in New Zealand. Lean Culture and other philosophies that embrace continuous improvement need the active involvement of leadership to operate effectively. For Lean Culture to operate effectively, the teamwork of the management and the leadership has to be paid a laser-attention because for the employees in the organization to abide by the lean-ways of doing things, they need the management to lead the way so as to imitate.

The transition from conventional construction into Lean Construction through the effective operation of Lean Culture is not an easy task and it requires the right collaboration from the most important set of personnel in an organization. According to Achanga et al. (2006), how successful lean manufacturing would be predicted by four primary factors which are: (1) leadership together with management; finance; skills and expertise; and an organizational culture that embraces the key pillars of lean which are respect for people and continuous improvement. The findings in this research from both the literature review, systematic review, and interview data analysis also support this work of Achanga et al. (2006), even though they are not of the same subject as the current study investigates Lean Culture for the application in Lean Construction in New Zealand.

The role of the leadership of the organization was found to be very important and the absence of good leadership may lead to a struggling Lean Culture operation. The leaders such as the top-ranking personnel and the management of an organization must be ready to lead the way for the other employees. On the aspect of finance, from the analysis of the data, we have been able to find that deploying the service of lean coaching and the application of target-value design to monitor every process may help minimize cost associated with Lean Culture implementation. In addition, it was later deduced still from the leadership and management of an organization that if there is effective leadership such as transformational leaders in an organization, the cost associated with training and educating employees may be drastically

reduced because the imitation of the leaders by the employees gradually induces the Lean Culture in their thinking, behaviours, and acts.

And of course, if this could be achieved then the handling of the tools for the effective operation of Lean Culture would be made easier. From this, it can be inferred that establishing good leadership in an organization may handle most of the Human Capital-related challenges to the implementation of Lean Culture. Nevertheless, having established good leadership for the organization, it is imperative to focus on employee empowerment through training and education. Managers are the responsible personnel for an organization in decision-making (Forbes & Ahmed, 2020). In other words, lean thinking is a function of Lean Culture such that Lean Culture has to be in operation before it can influence the behaviours and deeds of the employees, managers, directors and stakeholders. The truth is that Lean Culture requires time, and a long-term commitment is required for its fully effective operation in an organization. This fact was backed by the results of Emiliani (2006). According to Chase (2004), for lean philosophy to have a good stand in a medium-sized company, a minimum of 3-5 years is required. According to the findings of Mader (2005), the presence of strong top management leadership is required for a Lean Culture to operate effectively. The communication identified by the experts as one of the primary barriers to implementing Lean Culture can also be solved sufficiently with the help of good and strong leadership, as the initiation and implementation are done through effective communication. So, therefore, the barriers to the implementation of Lean Culture can be handled through upfront planning. From the analysis of the interview data, it was found that a structured stages plan could help to have a good laid-down approach to implementing Lean Culture successfully.

Secondly, the presence of transformational leadership in an organization could handle many (Human Capital-related) barriers treated in this research associated with the successful implementation of Lean Culture. For instance, the respect for people pillar of Lean Culture is more inclined to the behaviour and gestures of involved personnel in an organization. Additionally, the continuous improvement of the personnel must be internally driven, or else it would not work. Thirdly, the communication of information from the top-ranking personnel to the least must be excellent. There is a difference between passing information across to a set of people and communicating with them. The former does not care about how the information is being passed across; the latter cares about how it is being passed across.

6.5 Summary

This chapter focused on discussing the findings. First, the research gap, research problem, and questions are restated in the introduction section. Secondly, the findings of the research were summarized by developing the framework to improve the Lean Construction Implementation. Furthermore, the developing the framework and the validation the framework are discussed. Moreover, the framework is presented graphically. Thirdly, the results were interpreted into different themes identified through the research by highlighting the Human Capital related barriers and the strategies to improve these barriers. Lastly, this chapter discussed achieving the objectives of the research. The aim of the research is to develop a framework for improving Lean Construction Implementation. This developed framework guides the industry professionals working in the construction industry on how to implement strategies to overcome the Human Capital barriers in implementing Lean Construction practices. It is therefore hoped that the framework developed in this study will overcome any hindrance to productivity and efficiency in construction activities.

CHAPTER 7 CONCLUSION AND RECOMMENDATIONS

The previous chapter discussed the research findings in line with the existing literature and presented the developed framework to improve the Lean Construction Implementation from Human Capital perspective. This chapter presents the conclusion, recommendations, Contribution to the theory, implications for the construction industry, limitations, and further research areas. The section headings and the contents are shown in Table 7.1 below.

Section headings	Section content
7.1 Conclusion	This section summarizes all chapters of this thesis, highlighting the barriers and strategies to overcome them for Lean Construction Implementation, research methodology, and key findings.
7.2 Recommendations	Recommendations cover four aspects; the significance of Lean Culture, how to develop a Lean Culture, barriers, and strategies to create a Lean Culture.
7.3 Contribution to the Theory	The new knowledge added through this research is presented in this section.
7.4 Implication for the construction industry	This section discusses the contribution to the construction industry from this research.
7.5 Limitation	The limitation of conducting this research is discussed in this section
7.6 Further research areas	At the end of this thesis, the future research areas are proposed.

Figure 7-1 Chapter 7 section headings and contents

7.1 Conclusion

From this research, we have been able to make a good justification for the objectives of the research. The research aimed to develop a framework to improve the Lean Construction implementation from the Human Capital perspective. A comprehensive framework has been developed from the participants' responses, which are professionals in the construction industry, literature-review, and systematic review. The framework proposes Lean Culture as a solution to the barriers to the implementation of Lean Construction. This framework is graphically presented in section 6.6 and demonstrates the link between three domains: namely Human Capital, Lean, and Construction. Furthermore, this framework symbolizes the most critical Human Capital barriers and suggests the appropriate strategies to improve Lean Construction Implementation. Moreover, these barriers and strategies are categorized into various themes related to Human capital. These themes are attitudes, awareness,

communication, education, interest, leadership, teamwork, and training. When implementing the recognized strategies, a Lean Culture is created, and the Lean Construction Implementation is progressed.

Considering the challenges facing conventional construction methods in New Zealand, it became significant to study viable methods for construction projects to improve productivity and efficiency. Lean Construction is one of those approaches, but this method still faces numerous numbers of challenges or barriers to its effective implementation and operation in New Zealand. From this research, we have identified various barriers to the implementation of lean construction and interestingly we observed the chain relationship among the barriers. From this chain relationship, the likely solution to the challenges is suggested. Note that the primary goal of the research was to suggest strategies to improve the Lean Construction Implementation and the therefore this research provided several approaches to implementing Lean Construction in New Zealand.

From the literature review (see section 3.7), various Human Capital barriers to the implementation of Lean Construction have been identified. These barriers are related to attitudes, awareness, education, interest, training, leadership, and teamwork. According to Adegbembo et al. (2016), a lack of interest among construction parties to sit for a weekly review meeting to solve the problems causing project plan failures has been a barrier to the implementation of lean construction. From this, we can infer some factors that could be responsible for this barrier: lack of leadership and lack of interest in Lean Culture. According to the systematic review and the results obtained from the interview data analysis in this research, lack of leadership and lack of interest are among the top barriers being identified against the successful implementation of Lean Culture in New Zealand. Senior management is critical to benefiting from Lean Construction and implementing a successful strategy. Higher management must devote enough time and money to developing an efficient plan to update management and incorporate fresh Lean Construction ideas. However, according to investigations by Enshassi et al. (2021), a major barrier to advancing the goals of Lean Construction is top management's failure to exert true leadership. So, in this research, we have identified many barriers to implementing Lean Construction in New Zealand and most especially, we were able to associate many of the other barriers to the lack of leadership, which give birth to the lack of interest of the employees.

Construction industry is an industry with diverse kinds of people with different backgrounds. Lean construction and Lean Culture require primarily carrying everyone along in achieving the organization's goal. Considering the fact that the people have different cultural backgrounds, the Lean Construction has to be implemented so that a common ground is reached in the aspect of organizational culture. Creating a Lean Culture simply means calling the attention of everyone to waste and the removal of this waste in the system. Lean Culture requires self-assessment in whatever each team member does; this means the employee follows the facts of a matter than their own opinion. Hence, they are considered essential human-related barriers to implementing Lean Culture. When compared with the results obtained from the literature review, they are similar, and it connotes the importance of these barriers to the successful implementation of Lean Culture in construction industry in New Zealand. Nevertheless, we have found a strong relationship between leadership as a barrier to the implementation of Lean Culture and the effective operation of Lean Culture in the construction industry in New Zealand. Lean Culture and other philosophies that embrace continuous improvement need the active involvement of leadership to operate effectively. For Lean Culture to operate effectively the teamwork of the management and the leadership has to be paid a laser-attention because for the employees in the organization to abide by the lean ways of doing things they need the management to lead the way so as to imitate.

To improve the interests of the participants in Lean Construction, three (3) approaches are proposed in this research as regards ways to mitigate the lack of interest in Lean Culture in the construction industry in New Zealand. Firstly, the application of Lean Culture in each section of a construction company must be identified. When this is placed, targeting the set of people to carry out the implementation may become easy. Secondly, it would be of a great choice to educate the employees on the disadvantages and drawbacks of traditional construction methods. Enlightening the employees while the switch to Lean Culture is better could open the mind of the employees to learn. Thirdly, the advantages and the ways through which the successful operation of Lean Culture could impact the growth of the company must be explained to the employees. The goal is to create an inner-driven force for the employees to surrender to learning Lean Culture and embracing the change that it brings to them. Lastly, for the successful operation of Lean Culture, the national, geographical, and organization must be

blended into the culture of concern – Lean Culture. Above all, communication in the industry must be paid good attention and this can be done in many ways as stated in this research.

7.2 Recommendations

A set of recommendations are made in this section based on the findings of this research. First, it is recommended to consider as creating Lean Culture is significant. Secondly, how to develop a Lean Culture is proposed. Next, the challenge of creating a Lean Culture is suggested. Importantly, a set of guidelines to overcome these challenges are recommended. Finally, all recommendations are summarized in this section. The significance of Lean Culture is presented below.

7.2.1 Encourage the importance of Lean Culture.

This research has combined different research strategies to study the barriers to implementing Lean Construction, especially the Human Capital-related barriers. From the literature review, several barriers were identified, using the systematic review technique some additional barriers to the successful implementation of Lean Construction were also found. The primary data obtained from the experts in the construction industry also revealed some interesting Human Capital-related barriers to the implementation of Lean Construction in New Zealand. In this section, some recommendations are provided primarily based on the results obtained from the research strategies utliszed. Human Capital is the economic worth of an employee's experience and expertise (Pasban and Nojedeh, 2016). Human Capital encompasses assets such as competence, training, education, health, intelligence, and other qualities that companies value, including commitment and reliability (Tsaurai and Ndou, 2019). Consequently, it is an intangible asset or characteristic that is not (and cannot be) reported on a firm's financial statement (Igbalajobi, 2015).

Human Capital is thought to boost productivity, competitiveness, and profitability (Chulanova, 2017). The greater a firm's investments in its personnel, the greater its prospects of growth and competitiveness. The rapid growth of urbanization and global economic growth coupled with the increasing population across the globe has caused increasing demands for different kinds of infrastructure for different purposes. Many challenges have surrounded the construction sector in the past few decades and have caused the construction sector's productivity to decline

significantly. These challenges can be related to various factors such as mismanagement, lack of innovation, substandard quality, excessive rework, resource, and time overruns (Khaba and Bhar, 2015). Therefore, new approaches to solve these challenges must be deployed to improve the production level rapidly. Operational improvement can be significantly achieved by applying Lean Construction. Primarily, Lean Culture can achieve improved quality and productivity enhancement in the construction sector. Lean construction has been defined as improving processes and products based on the construction industry's requirements by effectively eliminating waste (AlSehaimi et al., 2014). Next, it is recommended to identify the barriers in developing a Lean Culture.

7.2.2 Defeating the barriers to Lean Culture

Before the practical implementation of lean-to-construction projects, organizations must conduct research to identify the barriers that prevent leanness of the organization, which eventually constrain the lean's success (AlSehaimi et al., 2014). The reason behind the identification of barriers prior to the practical implementation of lean is that there is a higher probability of lean implementation being successful when tailored towards specific barriers (Forbes and Ahmed, 2020). Virtually every company would want to have the results that Lean Construction gives. However, the results are the integration of systematic sequential subtasks that effectively solve critical barriers. Many studies have identified various barriers to implementing lean (Sarhan and Fox, 2013). However, the outstanding critical research is how these barriers are interrelated and the approach to solving them based on their relationship.

7.2.3 Identifying the challenges to creating the Lean Culture

The challenges related to the architectural design are first provided with recommendations for handling them. This relates to the architectural design and the preliminary detail evaluation to start a construction project. Conceptual, process and product design are all part of the lean design phase. Although it deviates from the conventional design approach, it builds on the results of the project definition phase. The linearity of traditional design is one of the significant lapses of the design. When considering architectural projects, the primary designer is the architectural firm and support is received from the design engineers, such as the people in structural engineering, mechanical and electrical engineering. Conventionally, preliminary drawings are provided by the architects, which is done for other disciplines for the stages

involved in the project. Then the architectural framework is later modified by the engineers by adding their design parameters. According to the participant's responses to the question relating to the cause of delay in project delivery, many reported the design adjustments. For instance, *"This is a major challenge in my section as oftentimes we have reason to adjust our designs and usually takes additional time and resources."* From this response, it can be deduced that project delivery delays often accompany design adjustments. It is then suggested that the architectural design for the construction be thoroughly evaluated prior to the commencement of the project to prevent excessive errors that warrant correction and delays. This evaluation could be in the form of double-checking the design compliance with the laid down implementation; more or less like visual implementations with the personnel involved. According to the conceptual framework designed for the implementation of Lean Culture, the challenges related to the architectural design can be effectively managed through the teamwork of the personnel and construction sections involved. If the engineers, quantity surveyors and lean manager could work together, the adjustment may be done without significant effect such as time and resource overruns.

Another challenge that has been observed from this research is related to the issues that the employees encounter with the materials used for the construction. Of course, there are various types of materials, but specifications must be followed if the customer's satisfaction aspect of Lean Culture will be achieved. It was observed that according to the participants in the survey some of the materials delivered by the other partnering companies are substandard, often resulting in time and resource overruns. The materials quality evaluation falls under lean supply. The product design, detailed engineering and fabrication are all in the lean supply. It involves the collection of the process and product to be used at the beginning of the project, which dictates the needful materials and the time to be delivered for the project. In addition, lean supply can significantly reduce the lead time associated with project information requirements. Materials quality evaluation relates to the re-evaluation of goods and materials for construction. According to the participant's responses to the question that treats the delivery delay, *"monitoring the products for the construction requires some systematic process which can take a longer period for accomplishment",* the materials being used for construction often go through evaluation probably to affirm the compliance with the requirements.

7.2.4 Creating a Lean Culture

For instance, this could be verifying the steel for casting if it is strong enough for the purpose, and of course, if it fails, then this might delay the project and consequently tampers the lean aspect of customer satisfaction. This material quality evaluation also falls under the management of materials, reflecting the value placed on the high-quality service associated with the Lean Culture. In Lean Culture, one of the main pillars is continuous improvement, which involves embracing perfection in the products and products (Ahmad et al., 2017). In the case of materials quality evaluation, it is imperative to cultivate a culture of excellence in service delivery by using high-quality materials to meet the customers' satisfaction. In the Lean Culture conceptual framework, the perfection goal is a key factor in sustaining the continuous improvement pillar of Lean Culture. Therefore, for this pillar to be conserved in Lean Construction, it is recommended that the construction industry chase after perfection in all the services provided to the customers.

Having a laid-down structure for the execution of each step of the construction activities can significantly impact the successful operation of Lean Culture in Lean Construction Implementation. This deals with the construction stages and how they can significantly influence the project. In Lean Culture, orderliness is one of the critical indicators of Lean Construction in an organization, and orderliness falls under the planning/control phase. The planning/control phase comes when the design phase has been concluded and the evaluation has been completed; after the supply phase, when the quality of the materials has been concluded and the members of the team have been identified, then having a laid down structure for the implementation of each stage of the project could be a smart approach to avoid errors with ripple effects on the project. For instance, target-value design can be used to prevent errors associated with detailed design. Target-Value Design refers to the specific estimation of design and not estimation based on the detailed design. With the target-value design, each of the involved engineers can work independently on the part of the design related to their function, preventing issues associated with many projects in construction. Additionally, with the help of stage-structured plans, many early design decisions can be corrected before fully implementing each project stage. Otherwise, errors would occur, fixing the problems would take much longer, and the effort would be wasted. These associated wastes due to improper planning are not in Lean Culture; therefore, Lean Culture is not achieved.

For this recommendation to be achieved in Lean Construction, transformational leadership is required to ensure that every member of the team unanimously supports the structures designed to follow for the projects. Because the unavailability of a true leadership that believes in Lean Culture and its benefits would lead to employee's discouragement due to the lack of motivation from the part of the leaders. Lean Culture cannot be engineered neither can it be paid for on the counter rather it is a process through conscious effort of controlling behaviours and doing things in the organization. In other words, the effective implementation of Lean Culture has potential to uttering the way we think as a team, talk to one another and customers, act and react to every critiques. It is like changing/working on the minds and hearts of the people; this would be impossible without effective leadership.

Having established that there is a poor awareness of lean construction in New Zealand, and in attending to this problem we proposed the application of Lean Culture. Part of the ways of solving this problem as suggested in this research was to ensure that there is adequate communication within and without the industry. The recommendation will just be in form of reinforcing what already highlighted. In the first place, the communication must be placed a laser-attention. The word communication often appeared in the interview with the experts, and many of them declared that for the Lean Construction in New Zealand to find its root and be established, it must be understood. This is a long process because for the people to understand the concepts of Lean Construction, the approach to which the information is passed across to the people must be developed critically. This appears to be a vital barrier with high potential, making the imitation of the other barriers easier because it may be difficult to get people along in the pursuit of Lean Culture when the people have no idea about what it is all about. From the literature review, it was found that lack of awareness of Lean Culture was very rampant in the construction industry and no concrete lean philosophy have been in operation for the implementation of Lean Culture (Khaba and Bhar, 2017). According to the other literature, the awareness of the Lean Culture has to be improved significantly for the Lean Construction to be successful in New Zealand. Average personnel probably would tell you that they have no understanding or are not aware of what lean construction entails, let alone Lean Culture. Although it is a difference between being aware and being educated, the former is the first step toward the later. So, the deployment of Lean Culture has to take its root from getting the personnel aware of Lean Construction, and then the Lean Culture would gradually be

welcomed and practiced. One of the ways to get people aware of lean management is to substitute every management stage of construction with a Lean Construction approach.

In other words, the word “lean” must always accompany the word “management” as out of curiosity, many would attempt to find more information about Lean Construction, which ignites the acceptance of Lean Culture. In addition, the core values of Lean Construction can be written at key locations in the construction project to remind the personnel what the goal is frequently. Categorically, it is recommended that the companies communicate the culture upon which the operation of the company runs. In other words, for every worker in an organization aiming to run Lean Culture must be inducted into the Lean Culture by providing them with every available means of information. Secondly, another approach to tackling the unawareness Human Capital-related barrier is cultivating the habit of engraving key concepts of Lean Culture at peculiar places, preferably a place of public gathering. So that through multiple encounters with these concepts it may become a part of them, and their behaviours tend to follow the trajectory of the lean concepts. In other words, the already-consumed information in an effortless-manner influences their thinking and deeds towards their responsibilities. Thirdly, another key approach to mitigating the effect of unawareness is the inclusion of “lean” in every management word in the organization. This is also similar in effect to the second approach because by the time each worker learns to use “lean management” in every of their conversation, by default their subconscious mind is programmed by the concept of lean and whenever they could learn further about lean, they would approach the learning with a curious mind. This barrier is highly essential to solving other barriers related to Human Capital.

Leadership is key to seeing Lean Culture thrive. Many practitioners have seen their profitability double or triple by utilizing Lean Leadership methods without significantly increasing their investment. This reawakening demonstrates how crucial it is to value the human aspect, which is essential to the Lean Process. Full involvement of employees, holistic perspective of the operation; constant recognition and rewards; and dedication to innovative behaviour and synergy across the board are key Lean tools for managing employees. Several tools are available today in lean manufacturing to motivate and enliven employees. They are urged to reason, cut out waste, and look for methods to create value. They need to be convinced that when the business thrives, they will as well. The empowerment from being encouraged to speak out helps people closest to the process identify and resolve issues, fostering a "Continuous

Improvement" culture throughout all processes. The suggested course of action is to begin by fostering trust via collaborative issue-solving, followed by incorporating knowledge of room for improvement into one's routine on a production floor.

As a result, a conforming staff transforms into a fully involved workforce. The primary means of implementing this engagement is leadership. Time and time again, mentorship, training, and team building are the most efficient catalysts for good change. The Lean Leader consistently encourages employees to participate by exposing those who thesis to him to the whole system, from the beginning to the end of the value chain. This activity's main gain will be the identification and advancement of fresh talent and future leaders. In this process, rewards and recognition are crucial. Unquestionably, praising the collective above the individual fosters team spirit. It is ideal for recognition when it is not directly related to the "bottom line." Nevertheless, the well-known "Gain Share" system, in which the firm's profit increase is split among the corporation and its staff, has also shown to be a highly motivating method. A firm's need for Human Capital cannot be overstated or ignored. Lean is a recipe for improving quality. Thus, it makes sense always to be mindful of the "condition of the staff" and how engaged, empowered, and integrated it is. Attitudes and wants must be watched over and modified to keep in touch with the psychological makeup of a firm's personnel. Human Capital will face new issues daily, but a firm can always be flexible by diligently and consistently using the Lean tools. Lean is the best force for change, and no component of the Lean Process is more crucial than Human Capital.

Monitoring construction projects is one of the backbones of Lean Construction, as all other stages depend on it. Monitoring each stage of Lean Construction is vital for effective operating Lean Culture in New Zealand. It may be very easy to execute Lean Construction, but it will be difficult to sustain the process. Construction industry is a very dynamic sector in which people involved for a project may differ for another, making implementing Lean Culture a bit difficult. But suppose there could be a system whereby the processes involved in a project are monitored from the beginning to the end. In that case, a regulatory policy may take care of the Human Capital-related barriers. Process monitoring is another phase of Lean Construction that spans from the beginning to the end of the project. The effective operation of Lean Culture depends mainly on managing the processes involved in the construction. The design evaluation needs to be monitored to ensure an adequate evaluation of the design. Although the Lean Culture

requires the team members to do the right thing even in the absence of supervision, sustaining the system requires process monitoring. In the process, monitoring a construction project's progress can be tracked through several methods, and how the project performs can be identified. Using the initiation and completion of a project, the status of the involved activities can be estimated. This is one of the fundamental approaches to applying the Lean Culture, as each construction phase is effectively monitored. Most importantly, initiating and completing a process works best when an activity has a shorter implementation period, such as in the case of materials quality evaluation prior to their use in the project. By this, the incremental milestone can be tracked due to the sequential decomposition of the tasks into subtasks.

In terms of the cultural background diversity, this relates to the cultural differences among the team members of an organization. The construction industry has diverse kinds of people with different backgrounds. Lean construction and Lean Culture primarily carry everyone along to achieve the organisation's goal. Because people have different cultural backgrounds, lean construction must be implemented to reach a common ground. Creating a Lean Culture means calling the attention of everyone to waste and the removal of this waste in the system. Lean Culture requires self-assessment in whatever each team member does, which means the employee follows the facts of a matter rather than their own opinion. Of course, each personnel would have a different opinion about a case. However, following the facts associated with Lean Culture, an excellent common ground will be achieved, and this uniformity enables the effective operation of Lean Construction. Working together is one of the backbones of Lean Culture; it requires learning, unlearning, and relearning. So, for Lean Construction to be effective in implementation, the pool of personnel with a cultural difference has to be collectively bounded to the organisation's goal through the adherence to Lean Culture facts. On the part of the lack of interest from the employees and management, this has to do with also the lack of awareness whereby the advantages associated with Lean Culture are not being known to the management, let alone the employees. Then, it is important that the lack of interest is provided with means of mitigating it. Three (3) approaches are proposed in this research as regards ways to mitigate the lack of interest in Lean Culture in the construction industry in New Zealand. Firstly, the application of Lean Culture in each section of a construction company must be identified. When this is placed, targeting the set of people to carry out the implementation may become easy. Secondly, it would be a great choice to educate the employees on the disadvantages and drawbacks of traditional construction methods.

Enlightening the employees while the switch to Lean Culture is better could open the mind of the employees to learn. Thirdly, the advantages and the ways through which the successful operation of Lean Culture could impact the growth of the company must be explained to the employees. The goal is to create an inner-driven force for the employees to surrender to learning Lean Culture and embracing the change that it brings to them.

7.2.5 Summary of recommendations

In summary, it is recommended that for adequate awareness of Lean Construction, there has to be communication and elaboration. Communication is the sense that the people have to be informed, and various approaches have been suggested in this research. All approaches summarize that the environment of Lean Construction should be immersed in Lean Culture, and this is possible by altering some ways of doing things. If the communication can be solved, then it is very probable that lean construction will survive. Lean construction needs Lean Culture to thrive. Lean Culture needs a set of people that respect other people and are willing to improve continuously. This is where the place of elaboration comes in. The concept of Lean Construction has to be opened to the people, and this is possible through various means, such as education, training to mention a few. If people could get aware sufficiently, then the rest of the Human Capital-related barriers would be easy to solve. Leadership: On the part of the leadership as a key Human Capital-related barrier to the implementation of lean construction. For the Lean Culture, which is a way of solving the challenges facing the effective operation of Lean Construction in New Zealand, a need for leadership arose during the literature review, systematic review, and interview data analysis.

The leaders have to lead the way, and this is very paramount for Lean Culture to operate in Lean Construction. In the first place, the leaders, mostly the senior managers, have to be humble and create friendships with the employees so that the fear of rejection may be prevented on the part of the employees. This has a way of bringing both the management and employees closer. In addition, transparency must be established between the leaders and the employees. Transparency is the sense that the organization's culture must be related to everyone considered to uphold it, and the rationale behind the choice of the culture should be clear. People are more likely to support a notion when they understand why. Hence, it is recommended that the leadership of an organization implementing Lean Construction be humble and transparent as much as possible. The next stage is active teamwork among the people in the construction

industry. Teamwork goes beyond employees being in contact with themselves but thinking that reflects every decision made by each party involved in a construction project. If there is teamwork at work in an organization aiming at applying Lean Construction, then Lean Culture would be a thing of unanimous agreement. And when it is accepted, then practice becomes a thing of process. The construction industry is very diverse, and collaboration must exist for such a setting to sustain Lean Construction. The engineers have to work with the non-engineers, and the decision of a group of workers should favour the other. When there is polarization in the setting there, it becomes difficult for Lean Culture to operate. Lastly, on the part of teamwork, unity must be the goal in a Lean Culture environment. Every group member must see themselves as a pillar upon which the organization's success lies.

In this way, companies must concentrate their efforts on the formation of Human Capital to build a lean construction culture. As a high priority and necessity, the government and other professional organizations within the construction industry should give more importance to capacity building, innovation, and knowledge creation through the application of lean principles; this would help create the necessary change in paradigm that would engender Lean Construction Implementation. Additionally, strong management and leadership support are required to integrate Lean Construction practices into the operational culture of construction organizations (Nwaki et al., 2021). Management of construction enterprises must take the initiative in change and implement new practices that might boost industry performance and efficiency. Further, management should encourage employee engagement and creativity by offering training programs, encouraging and enabling them, and valuing their comments.

Implementing Lean Construction, even on a small scale, raises awareness of its advantages and difficulties. More businesses may gauge how well they match the lean principles by sharing the outcomes of these encounters to help foster goodwill and improve communication among all project stakeholders. This claim may be supported by early contractor participation, collaboration, and integrated design. More reliance on novel contract types and procurement strategies as opposed to the older design-bid-build methodology would further enhance stakeholder collaboration and eliminate disputes.

Next, it is important to present the contribution to the theory by achieving the aim and objectives of this research.

7.3 Contribution to the Theory

This section discussed the research gaps to identify which theory wanted to use in the research, research contribution, and theory to the contribution.

7.3.1 Research gap

This research attempts to address multiple gaps and in achieving subsequently, get valuable contributions. First, there are productivity and efficiency issues in the construction activities. Various construction management approaches have been suggested and implemented in the construction industry. However, still, the construction projects are complete with delays and cost overruns for many reasons. One of the key reasons is the existence of non-value adding activities in the construction processes. Lean Construction emerged to solve these numerous productivity issues and to make the process flow efficient. There are plenty of lean techniques derived from the manufacturing industry to implement lean practices. However, the Lean Construction Implementation is slow. When evaluating the barriers to Lean Construction Implementation, more than half of the barriers are from the Human capital area. Therefore, there was a dearth of an appropriate framework to improve Lean Construction from Human capital perspective. After describing the research gap, it is important to discuss how this framework contributes to the research domain.

7.3.2 Research contribution

First, this research extends the limited literature on Human capital barriers in Lean Construction Implementation. Our research is among the first to consider Human Capital development in Lean Construction Implementation. Secondly, this research identifies the barriers to Lean Construction Implementation. Hence, what are the reasons for the slow implementation of lean Construction are explicit in this research. Thirdly, there is no previous research to the best of the author's knowledge, and through search, peer-reviewed databases have empirically explored the Human capital barriers and strategies to overcome them in Lean Construction Implementation. Fourthly, improving lean Construction Implementation from Human Capital perspective is a new lens for construction professionals to manage construction activities from Human capital perspective.

7.3.3 Contribution to the theory

Lean Culture has been found to be a compelling theory for improving Lean Construction Implementation from Human Capital perspective. Lean Culture is a culture that embraces learning, focuses on customer satisfaction, and strongly incorporates the continuous improvement of people and products or services (Adu and Opawole, 2019). By removing wasteful tasks, processes can become "lean" to give "more with less" resources. (Kafuku, 2019). Eric (2022) agrees that Lean adoption requires significant and ongoing support from the highest levels of an organization. He believes that “a successful lean deployment is 20% dependent on tool expertise and 80% dependent upon the leadership and culture in which they are utilized. Therefore, by creating a Lean Culture, the Lean Construction Implementation can be improved by implementing the strategies that identify. Next, how this contribution to the theory is implicated for the construction industry is discussed.

7.4 Implication for Construction Industry.

Lean Construction emerged in the early nineteen nineties as a new way of managing construction activities to solve productivity issues in the construction industry. Lean Construction is implemented in many construction industries and has reaped many benefits by several countries. However, it is evident that Lean Construction Implementation is still new and slow in many countries, including New Zealand. Hence, this research initiated to identify the barriers to lean Construction Implementation and revealed that more than half of the barriers are related to the skills, experiences, knowledge, attributes, and capacities of people working in the construction industry. Therefore, the framework developed through this research supports implementing Lean Construction by implementing the suggested strategies and can benefit many parties in the construction industry. Further, this framework would enable them to improve the productivity and the efficiency of their construction processes through the minimization of flow waste which is non-value adding activities with probable savings on cost and time. In addition to clients, contractors, and consultants who are the main stakeholders of the construction industry, there are also a considerable number of key professionals such as architects, engineers and quantity surveyors who are employed by various organizations involved in the construction industry. These professionals can play a vital role in the construction industry by using this framework to improve the implementation of Lean Construction tools and techniques.

The clients, both individuals and organizations, can benefit from this framework as it helps them reduce construction costs by minimizing non-value adding activities and making construction processes lean. The return benefits they gain by spending their funds on a particular project, which can even be considered an investment, will increase if they can minimize NVAAs in the project. The construction cost per square meter of floor area in New Zealand is higher than the previous years' corresponding values, especially after the global Covid pandemic issues. Therefore, it becomes very important for clients to reduce the cost of their investments in future. They can use the framework developed through this study for this purpose, which can increase their satisfaction level, compelling them to make more investments in the industry, expecting higher returns.

In New Zealand, contracts in the construction industry are generally awarded through a competitive bidding process. The prospective contractors who participate in the bidding process do their best to lower the amounts they quote for the services they offer as much as possible. This framework, if used by them, will minimize their costs and they will be in a position to win the contracts by offering the lowest possible bid prices without compromising the workmanship and the quality of the materials they use. It is common in the construction industry for contractors to use inferior quality material and poor workmanship to cut down their costs. By using lean techniques, they can still reduce their costs and retain the profit margins expected at the time of bidding while maintaining the required standards in the quality of the material and the labor they use.

Consultants have to play a vital role in procurement-related activities of construction projects where a considerable number of professionals are involved. Often it is the consultants who get criticized for project delays, cost overruns and underestimated budgets. When contractors adopt lean techniques these undesirable outcomes of a project are minimized resulting in client satisfaction. The clients will then begin to appreciate the services of the consultants without blaming them unnecessarily. This better recognition will create more job opportunities for the consultants.

In overall, construction is a labour-intensive industry and New Zealand Construction Industry identifies the one of the major challenges as “shortage of skilled workers”. According to the construction industry survey 2021, it was revealed that the number one challenge is skilled

shortage and recommendations are workforce development leadership, support of long-term work readiness programs, on-the-job training, connect the industry with schools. Therefore, this framework will help project managers, site managers and other professionals irrespective of whether Client or the Contractor and both stakeholders may gain the befits for the value for money by optimizing the labour involvement by defeating the Human Capital barriers to implementing Lean Construction.

7.5 Translating the new knowledge to the industry practice

The developed framework will be shared with the New Zealand construction industry in several ways. The first best opportunity is to conduct a webinar through professional institutions such as the New Zealand Institute of Quantity Surveyors, Engineering New Zealand, and the New Zealand Institute of Architects. This is an opportunity for construction professionals to know the most critical barriers and the most suitable strategies to implement Lean Construction from a Human Capital perspective. Next, the summary of the research findings will be sent to the interview participants who contributed their knowledge and experience to this research. These participants were from different disciplines (Architects, Quantity Surveyors, Engineers & project managers), and they may take the necessary initiatives within their previews.

Furthermore, the updated framework will be sent to the Expert panel who have already given their expert opinions to finalize the framework for addressing the Human Capital related barriers to improve lean Construction Implementation. Also, the researcher is an academic, and the findings are disseminated through the young graduates who work in the construction industry through their research activities. Last but not least, the researcher intends to develop a guideline in the form of a flyer to demonstrate how to address the Human Capital barriers in Lean Construction Implementation in the New Zealand construction industry.

7.6 Limitations

There are several limitations of this study. These limitations were mainly related to the collection of data. Data collection was confined to the professionals who work in the New Zealand Construction Industry. A good-sized sample of consideration as data saturation was needed. The sample size had to be limited to twenty-four based on the number of semi-structured interviews because meeting professionals individually took more time and was not

practical during the Covid outbreak. Also, this interview process was not longitudinal due to Covid Outbreak. It was identified that the level of implementation of lean techniques in the country is low, and therefore the knowledge in suggesting new strategies became a challenge for them. Although some lean techniques are being practiced, they are not known by name as lean techniques. It took some time to explain Lean Construction Implementation to them. Non-value adding activities are not considered as waste by professionals who took part in the surveys as most of them were aware of only material waste, with flow waste being invisible and intangible. Therefore, the research findings were limited to the gathered suggestions for the improvement of Lean Construction Implementation. However, the experts participating in the validation were armed with the implementation of Lean Construction from the Human Capital perspective, and it added extra value to the research.

7.7 Further research areas

This research has deployed and applied a qualitative approach based on semi-structured interviews to study the barriers to the implementation of Lean Construction in New Zealand and the likely solutions were also proposed. Literature-review was applied first, followed by systematic review, and thematic analysis of the primary data. For the future work, the systematic literature review could be improved by expanding the keywords. This research, "Lean Construction" were used to search the literature, but it could be expanded for the words to represent the lean techniques such as last planner, off-site manufacturing, prefabrication, or building information modelling. Also, the barriers found in this research could be further research by using grounded theory to iterate the barriers and see the most important factors to deal with and how it could impact Lean Culture. Grounded theory methodology would help researchers to construct the most appropriate strategies to adopt by contextualizing cases by the simultaneous development of those concepts, categories, and themes.

Moreover, in this research, the professionals in the construction industry were interviewed and none of the workers was considered. It would be more appropriate to collect data through the case study approach, where Lean Construction is implemented to assess the barriers and then suggest strategies to overcome them. Hence, it is strongly recommended that both workers and professionals are interviewed with the aim of juxtaposing their views for better accuracy of the result obtained in this research. Further research could also combine expert responses from various construction industries and then perform comparative analysis to infer the barriers and

chain relationship among the factors. This would help to detail the proposed framework for straightforward implementation. Lastly, the framework developed in this research can be improved by treating each barrier individual then apply them in various construction companies operating Lean Construction. Eight themes were identified in the framework, and then analyzed the data based on these themes. However, this framework can be further expanded, for example, with 'capabilities or soft skills of people in the construction industry.

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APPENDICES

APPENDIX A Ethics Approval

APPENDIX A.1: Ethics approval Stage 1

19 February 2021

Nicola Naismith

Faculty of Design and Creative Technologies

Dear Nicola

Re Ethics Application: **20/417 Framework for Lean Construction Implementation from the human behavioural perspective**

Thank you for providing evidence as requested, which satisfies the points raised by the Auckland University of Technology Ethics Committee (AUTEC).

Your ethics application has been approved for three years until 19 February 2024.

Non-Standard Conditions of Approval

1. Please include the whole withdrawal statement from the 'how do I agree' section of the Information Sheet template which is available on the Research Ethics website at http://aut.ac.nz/researchethics;

Non-standard conditions must be completed before commencing your study. Non-standard conditions do not need to be submitted to or reviewed by AUTEC before commencing your study.

Standard Conditions of Approval

1. The research is to be undertaken in accordance with the Auckland University of Technology Code of Conduct for Research and as approved by AUTEC in this application.
2. A progress report is due annually on the anniversary of the approval date, using the EA2 form.
3. A final report is due at the expiration of the approval period, or, upon completion of project, using the EA3 form.
4. Any amendments to the project must be approved by AUTEC prior to being implemented. Amendments can be requested using the EA2 form.
5. Any serious or unexpected adverse events must be reported to AUTEC Secretariat as a matter of priority.
6. Any unforeseen events that might affect continued ethical acceptability of the project should also be reported to the AUTEC Secretariat as a matter of priority.

7. It is your responsibility to ensure that the spelling and grammar of documents being provided to participants or external organizations is of a high standard and that all the dates on the documents are updated.

AUTEC grants ethical approval only. You are responsible for obtaining management approval for access for your research from any institution or organization at which your research is being conducted and you need to meet all ethical, legal, public health, and locality obligations or requirements for the jurisdictions in which the research is being undertaken.

Please quote the application number and title on all future correspondence related to this project.

For any enquiries please contact ethics@aut.ac.nz. The forms mentioned above are available online through http://www.aut.ac.nz/research/researchethics

(This is a computer-generated letter for which no signature is required)

The AUTEC Secretariat

Auckland University of Technology Ethics Committee

Cc: nilmini.thilakarathna@aut.ac.nz; John Tookey; Fei Ying

APPENDIX A.2: Participant information sheet for Stage 1

Participant Information Sheet

15th February 2021

Framework for Lean Construction Implementation from the human behavioural perspective

I, Nilmini Thilakarathna is a candidate of PhD AUT University, Auckland, New Zealand. I also work as a Senior Lecturer, department of Quantity Surveying, Otago Polytech, Dunedin on a permanent and full-time basis. My supervisors are Professor John Tookey, Associate Professor Nicola Naismith, and Dr. Fei Ying from the Department Built Environment Engineering, AUT, Auckland.

My research area is Lean Construction Implementation under the domain of Construction Management. The primary data collection method is "in-depth Interviews" using semi-structured questions. In this research, the participants are identified from four different professional categories, quantity surveying, engineering, architecture, and project management. Six of each category totalling 24 professionals are interviewed.

The research aims to develop a framework for improving the construction process flow by implementing lean construction from the behavioural perspective. This framework would help to mitigate the cost and time overruns in construction projects. The findings of this research may be used for academic publications and presentations.

It is pleasing to inform that you have identified as an interviewee for this research. Being mindful of your precise time, participation will not exceed one hour during the period of 15 January 2021 to 15 March 2021. I sincerely hope that you will be able to find an hour on a date for the interview. You have the option in selecting the mode of interview as face to face or virtual via Zoom, Teams, or Skype.

As a next step, I will be contacting you for an appointment in your workplace or any other public place which is comfortable for you. This interview will be voice recorded (if you consent to such a recording). A consent form will also provide you to remain anonymous. Your participation in this research is voluntary (it is your choice) and whether or not you choose to participate will neither advantage nor disadvantage you.

You are able to withdraw from the study at any time. If you choose to withdraw from the study, then you will be offered the choice between having any data that is identifiable as belonging to you removed or allowing it to continue to be used. However, once the findings have been produced, removal of your data may not be possible. AUT Health Counselling and Wellbeing is able to offer three free sessions of confidential counselling support for adult participants in an AUT research project. These sessions are only available for issues that have arisen directly as a result of participation in the research and are not for other general counselling needs. To access these services, you will need to:

- drop into our centres at WB219 or AS104 or phone 921 9992 City Campus or 921 9998 North Shore campus to make an appointment. Appointments for South Campus can be made by calling 921 9992.
- let the receptionist know that you are a research participant, and provide the title of my research and my name and contact details as given in this Information Sheet

You can find out more information about AUT counsellors and counselling on http://www.aut.ac.nz/being-a-student/current-postgraduates/your-health-and-wellbeing/counselling.

In the unlikely event of a physical injury as a result of your participation in this study, rehabilitation and compensation for injury by accident may be available from the Accident Compensation Corporation, providing the incident details satisfy the requirements of the law and the Corporation's regulations.

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, Associate Professor Nicola Naismith, nicola.naismith@aut.ac.nz P 09 921 9999 Ext 7949

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, *ethics@aut.ac.nz* , (+649) 921 9999 ext 6038.

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details:

Nilmini Thilakarathna

Senior Lecturer

Department of Quantity Surveying

Otago Polytechnic

M 021 207 1204 E nilmini.thilakarathna@aut.ac.nz

Project Supervisor Contact Details:

Associate Professor Nicola Naismith
Deputy Head, School of Future Environments
Faculty of Design & Creative Technologies
Auckland University of Technology
P 09 921 9999 Ext 7949 M 021028 93296 E nicola.naismith@aut.ac.nz

Approved by the Auckland University of Technology Ethics Committee on *type the date final ethics approval was granted*, AUTEC Reference number *type the reference number*.

APPENDIX A.3: Consent Form

Project title: **Framework for Lean Construction Implementation from the human behavioural perspective**

Project Supervisor: Associate Professor Nicola Naismith,
Deputy Head, School of Future Environments
Faculty of Design & Creative Technologies
Auckland University of Technology
P 09 921 9999 Ext 7949 M 021028 93296
nicola.naismith@aut.ac.nz

Researcher: Nilmini Thilakarathna
M 021 207 1204 E nilmini.thilakarathna@aut.ac.nz

- ○ I have read and understood the information provided about this research project in the Information Sheet dated 05 /01 /2021.
- ○ I have had an opportunity to ask questions and to have them answered.
- ○ I understand that notes will be taken during the interviews and that they will also be audio-taped and transcribed.
- ○ I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without being disadvantaged in any way.
- ○ I understand that if I withdraw from the study then I will be offered the choice between having any data that is identifiable as belonging to me removed or allowing it to continue to be used. However, once the findings have been produced, removal of my data may not be possible.
- ○ I agree to take part in this research.
- ○ I wish to receive a summary of the research findings (please tick one): Yes○ No○

Participant's signature:

.....……

Participant's name:

.....……

Participant's Contact Details (if appropriate):

……..

……..

……..

……..

Date:

Approved by the Auckland University of Technology Ethics Committee on type the date on which the final approval was granted AUTEC Reference number type the AUTEC reference number

Note: The Participant should retain a copy of this form.

APPENDIX A.4 : Interview Guideline

INDICATIVE QUESTIONS

GREETINGS..!!

Q1. What is your role in construction projects?

Q2. How do you describe your experience in delivering construction projects on time and within the budget?

Q3. Lean construction is a new way of managing projects. It is about minimizing the non-value adding activities that do not value the value project value. Several lean techniques are implemented in the construction industry to improve productivity and efficiency.
How would you describe your experience in improving productivity and efficiency in construction projects?

Q4. There are challenges in improving productivity and efficiency in construction projects. How do you describe these barriers to improve productivity and efficiency using advanced tools and techniques (for example, Lean Construction)?

Q5. According to your experience, what are the human capital (Experience/skills/attitudes) related barriers which prevent implementing new approaches (for example, Lean Construction)?

Q6. What strategies would you suggest within your expertise and experience to overcome these human capital-related barriers?

Q7. What are the effective ways of implementing these strategies in construction projects?

Q8. Finally, any other comments you would like to share around this topic we discussed today?

The end with a big thank

APPENDIX A.5: Ethics approval Stage 2

Auckland University of Technology Ethics Committee (AUTEC)

Auckland University of Technology
D-88, Private Bag 92006, Auckland 1142, NZ
T: +64 9 921 9999 ext. 8316
E: ethics@aut.ac.nz
www.aut.ac.nz/researchethics

26 July 2022

Nicola Naismith
Faculty of Design and Creative Technologies

Dear Nicola

Re Ethics Application: **20/417 Framework for Lean Construction Implementation from the human behavioural perspective**

Thank you for providing evidence as requested, which satisfies the points raised by the Auckland University of Technology Ethics Committee (AUTEC).

Your ethics application (second stage - experts to evaluate the framework developed from the first stage) has been approved for three years until 26 July 2025.

Non-Standard Conditions of Approval

1. Please tailor the Oral Consent Form to your study.

Non-standard conditions must be completed before commencing your study. Non-standard conditions do not need to be submitted to or reviewed by AUTEC before commencing your study.

Standard Conditions of Approval

1. The research is to be undertaken in accordance with the Auckland University of Technology Code of Conduct for Research and as approved by AUTEC in this application.
2. A progress report is due annually on the anniversary of the approval date, using the EA2 form.
3. A final report is due at the expiration of the approval period, or, upon completion of project, using the EA3 form.
4. Any amendments to the project must be approved by AUTEC prior to being implemented. Amendments can be requested using the EA2 form.
5. Any serious or unexpected adverse events must be reported to AUTEC Secretariat as a matter of priority.
6. Any unforeseen events that might affect continued ethical acceptability of the project should also be reported to the AUTEC Secretariat as a matter of priority.
7. It is your responsibility to ensure that the spelling and grammar of documents being provided to participants or external organisations is of a high standard and that all the dates on the documents are updated.
8. AUTEC grants ethical approval only. You are responsible for obtaining management approval for access for your research from any institution or organisation at which your research is being conducted and you need to meet all ethical, legal, public health, and locality obligations or requirements for the jurisdictions in which the research is being undertaken.

Please quote the application number and title on all future correspondence related to this project.

For any enquiries please contact ethics@aut.ac.nz. The forms mentioned above are available online through http://www.aut.ac.nz/research/researchethics

(This is a computer-generated letter for which no signature is required)

The AUTEC Secretariat
Auckland University of Technology Ethics Committee

Cc: nilmini.thilakarathna@aut.ac.nz; John Tookey; Fei Ying

APPENDIX A.6: Participant Information Sheet Stage 2

Date Information Sheet Produced:

20 July 2022

Project Title

Framework for Lean Construction Implementation from the human behavioural perspective

An Invitation

I am writing to you to look at the possibilities of sharing your knowledge and experience to my research study. I am Nilmini Thilakarathna, a candidate for Ph.D. AUT University, Auckland, New Zealand. I also work as a Senior Lecturer at, the Department of Quantity Surveying, Ara Institute of Canterbury. My supervisors are Professor John Tookey, Associate Professor Nicola Naismith, and Dr. Fei Ying from the Department of Built Environment Engineering, AUT, Auckland.

There are two data collection stages in this research, and stage one is already done. This is stage two which is to interview five experts in lean construction implementation, in New Zealand. I have identified you as one of the experts in the area of lean Construction Implementation to contribute to my research. Therefore, I invite you with this formal letter for you to participate in this study as an Interviewee.

What is the purpose of this research?

The research aims to develop a framework for improving the construction process flow by implementing lean construction from behavioural perspective. This framework would help to mitigate the cost and time overruns in construction projects. The findings of this research may be used for academic publications and presentations.

How was I identified, and why am I being invited to participate in this research?

A framework was developed based on the data collected at stage one of data collection. This framework consists of a set of barriers related to the human capital area in implementing lean construction, and a set of strategies to overcome those barriers. In this stage, the participants are identified from the New Zealand Construction Industry to refine and validate the developed framework. Five of experts in lean construction implementation are interviewed and publicly available information is used to identify the experts. It is pleasing to inform you that you have identified as an interviewee for this research.

How do I agree to participate in this research?

Being mindful of your precise time, a session of the interview will not be exceeded 30 minutes. Interviews will be conducted from 15 August 2022 to 31 August 2022. I sincerely hope that you will be able to find half an hour on a date for the interview. The interviews are face-to-face and online via Zoom, Teams, or Skype. At your convenience, you can choose the date, time, and virtual platform.

As the next step, I will be contacting you for an appointment that is comfortable for you. This interview will be voice recorded (if you consent to such a recording). A consent form will also provide for you to read and sign before commencing the interview. This can be done by sign, scanning, and returning to me, or you can copy the content of the consent form and send me in the form of an email, or you may give your oral consent before the interview commences and it will be voice recorded. You have the freedom to refuse or withdraw from the participation before or in the middle of the interview. You are able to withdraw from the study at any time. If you choose to withdraw from the study, then you will be offered the choice between having any data that is identifiable as belonging to you removed or allowing it to continue to be used. However, once the findings have been produced, removal of your data may not be possible.

What will happen in this research?

The participants will be asked semi-structured open questions, and these questions are appended to this information sheet for your reference. These questions are on the barriers to implementing 'lean construction' and the strategies to improve lean construction implementation. Twenty-Four participants are interviewed, and the data obtained from the participants are transcribed, analyzed, and findings are tabulated. As the second step of the research, a survey will be carried out based on the Interview findings to gather the information to develop the framework.

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, Associate Professor Nicola Naismith, nicola.naismith@aut.ac.nz P 09 921 9999 Ext 7949

What are the benefits?

I, the primary researcher, is a Ph.D. candidate who wishes to obtain her Ph.D. Qualifications after completion of this research study. Furthermore, I am a senior lecturer works at Otago Polytechnic, New Zealand, and this Qualification would be an added advantage as professional development in my career progression. Moreover, the research findings would be published for others to use. Significantly, academics and professionals in the construction industry may use these findings to improve their knowledge.

How will my privacy be protected?

Participants' details will not be shared with anymore outside of the research team. The data collected from you has a low probability of discrimination, harm, or unwanted attention resulting from disclosure. Confidentiality will be maintained by changing your identities such as names and organization, and other potential identifiers in a thesis or any publications resulting in the research. The consent form is attached to this letter for you to read in advance and to agree with. Due to the nature and size of the population being interviewed only limited confidentiality can be offered. However, your participation in this research is voluntary (it is your choice), and whether or not you choose to participate will neither advantage nor disadvantage you.

What are the costs of participating in this research?

Your participation in this research is a maximum of half an hour. The interview is designed to conduct ranging from twenty minutes to 30 minutes.

What opportunity do I have to consider this invitation?

You can take one month to consider the invitation, and after two weeks of the invitation, a follow-up email would be sent to you.

Will I receive feedback on the results of this research?

A one or two-page summary of the findings of the research will be sent to the participants.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, Associate Professor Nicola Naismith, nicola.naismith@aut.ac.nz P 09 921 9999 Ext 7949 M 021028 93296

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, *ethics@aut.ac.nz*, (+649) 921 9999 ext 6038.

Whom do I contact for further information about this research?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details:

Nilmini Thilakarathna

Senior Lecturer

Department of Quantity Surveying

Ara Institute of Canterbury

M 021 207 1204 E nilmini.thilakarathna@aut.ac.nz

Project Supervisor Contact Details:

Associate Professor Nicola Naismith

Deputy Head, School of Future Environments

Faculty of Design & Creative Technologies

Auckland University of Technology

P 09 921 9999 Ext 7949 M 021028 93296 E nicola.naismith@aut.ac.nz

Approved by the Auckland University of Technology Ethics Committee on *type the date final ethics approval was granted*, AUTEC Reference number *type the reference number*.

APPENDIX B: Paper Published PAQS Conference

This paper was written based on the Literature Review and published at PAQS Conference 2019

LITERATURE REVIEW: A CONCEPTUAL FRAMEWORK FOR PSYCHOLOGY IN LEAN CONSTRUCTION

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Auckland University of Technology, Auckland, New Zealand

ABSTRACT

Construction projects complete with cost and time overruns for various reasons. One of the major hindrances of flow process in construction activities is Non-value adding activities (NVAAs) such as

rework, defects and waiting. Lean Construction (LC) is an innovative approach which is linked closely to the overall life of a construction project to ensure its success by eliminating NVAAs. The purpose of this paper is to establish a conceptual framework to reflect the link between lean construction implementation (LCI) and psychology. Literature indicates that the LCI at the operation level is limited. Moreover, LC is still new to many countries in the construction industry globally. Literature suggests many reasons for slow LCI such as lack of organizational elements, integration, training, administration and transparency. However, few addresses the human side, which is the psychology perspective.

A preliminary literature review was carried out to identify the psychological aspects of implementing lean principles in construction flow processes. Findings reveal that there is an evident link between the flow process and psychology in lean construction implementation. A conceptual framework is then developed to demonstrates the relationships between lean, construction and psychology. The activities that do not add any value to the final product are merely a waste and need to be minimized. Only limited efforts have so far been made to improve the flow process in the construction activities. Lean construction is one such attempt made to apply lean production principles to the construction industry to minimize NVAAs in its construction processes and maximize the value provided to clients. Hence it is vital to identify the key reasons for slow LCI to explore the human perspective. This paper recognizes the link between the LC and Psychology in the construction flow process. Furthermore, the conceptual framework is proposed to demonstrate the link between LC and psychology.

Keywords: conceptual framework, lean construction, preliminary literature review, psychology.

INTRODUCTION

Research Problem

The construction industry has been suffering from a range of challenges. Including low productivity, insufficient quality, time and cost overruns, poor safety, frequent disputes, lack of innovation, project asking so long and always exceeding the client's budget (Lathem (1994); Howel and Ballard (1997); Eagan (1998); Smith et al (1999); Kagioglou et al (2000); Salem et al (2006); Thomas et al (2010); Emuze and Smallwood (2011); Al-Aomar (2012); Vilashini et al (2012);Sarhan et al (2017), Rieden (2018; Tezel et al (2018). The main reasons are insufficiency and waste with NVAAs within the construction projects, not adding any value to the final product. Therefore, the NVVAs incur costs and hinder the performance of the construction projects and need to be minimized. Most construction managers fail to execute projects efficiently (Mahfuth et al, 2019).Moreover, the industry is vulnerable to multiple wastes, overruns, delays, errors, and inefficiencies (Al-Aomar (2012). Furthermore, Senaratne & Wijesiri (2008) have revealed that a considerable amount of waste lies in the flow processes of construction. The greatest obstacle to waste removal, in general, is a failure to recognize it. This is prevalent in the construction industry because it is not well understood by the construction personnel (Alwi et al., 2002). Waste is generally associated with waste of material in the construction process while NVAAs such as delays, transportation of material and others are not recognized as waste (Alarcon, 2006). The construction sector has a wide range of activities, including the provision of professional and technical inputs. Activities that do not add value result in waste which absorbs resources and does not add any value to the final product and therefore, these NVAAs need to be eliminated. By eliminating wasteful activities, processes can become 'lean' providing 'more with less' resources (Womack and Jones, 2010). According to Aziz and Hafez (2013), the traditional thinking of most of the construction-related organizations is on conversion activities and flow activities and value considerations are simply ignored. LC is a new way to manage construction while minimizing the waste on flow activities. The goal of LC is to implement the project while maximizing value, minimizing waste, and pursuing perfection (Al-Aomar, 2012). However, lean construction implementation at the operation level is limited. Moreover, lean construction is still new to many in the construction industry globally. Many reasons for slow implementation have been suggested including, the lack of

organizational elements, integration, training, administration and transparency. However, few addresses the human side, which is the psychology perspective (Moaveni, 2019). Hence, the proposed conceptual framework proves the psychological perspective of the LCI.

First, the common problems in construction flow processes were identified. One of the key concern is identified as the activities which do not add any value to the final output of the project and these non-value adding activities need to be minimized or eliminated for a smooth construction process flow. The literature also confirmed that the extent of existing NVAAs in the construction process flow, which creates unwanted cost and time overruns. The literature was then reviewed to identify the innovative management approaches to identify to improve the construction process flow, and Lean Construction was identified as the most appropriate ways of minimizing NVVAs in the construction process flow. It was revealed that there is a slow implementation in lean constructions in construction settings for many reasons. Moreover, the literature review was further carried out to identify the key drivers of lean construction implementation. These findings revealed that there is an evident link between psychology and lean construction implementation.

Research Method

A preliminary literature review was carried out to identify the psychological aspects of implementing lean principles in construction flow processes. The key focuses of the literature research were the prevailing issues in the construction sector, lean construction as a new approach, and the barriers in implementing LC. The journal articles published for recent years were the main source for the literature review. The keywords were identified as, NVAAS, LCI, and barriers for LCI. More than fifty number of journal articles were reviewed through google scholar, library resources, and lean construction institutes in different countries. In addition to this, the researcher's previous study on lean construction was also reviewed for key findings.

Literature for the last twenty years on lean construction implementation was critically evaluated to identify the link between lean construction implementation and human side of it. There were many pieces of literature from 1998 to 2005 on lean construction and its implementation. Also, this literature discusses the NVAAs as a waste which needs to be eliminated or minimized by implementing lean techniques. There were few kinds of literature from 2006 to 2012 and again, there is an explosion in the discussions of the Lean construction implementations from 2012 up to date. Guidelines, benefits and challenges were discussed throughout the whole period for the last twenty years.

As the next step of the literature review, the lean construction implementation was examined within developed and developing countries. Lucid chart software was used to frame the literature findings into a format. Moreover, the recently developed conceptual frameworks were examined through the literature review to refine the framework. Finally, a conceptual framework to demonstrate the link between LC and psychology was developed. This conceptual framework would further develop in future through a systematic Literature review followed by a primary data collection from different construction professionals in the Pacific Association of Quantity Surveying(PAQS) countries. It would be further detailed and refined via case studies from New Zealand Construction Industry. The preliminary literature review shields three main sections. First, the research problem which is the existence of NVAAs in the construction process flow, and secondly, the most suitable approach to the research problem as LC implementation is discussed. The third section is to identify the link between LC implementation and psychology. Therefore, the next section of the paper presents the key findings of the preliminary literature review on NVAAs which hinder the construction process flow.

NON-VALUE ADDING ACTIVITIES (NVAAS)

NVAAs have been defined as the activities which do not add any value to the final product are merely a waste (Koskela, 1992). Most of these activities are intangible (Senaratne & Wijesiri, 2008) and invisible. Activities that do not add value are wasteful and should be eliminated. In the context of both construction and production, waste is primarily defined under seven categories (Ohno, 1988). These are defects (errors), delays, over-processing, overproduction, excess inventory, unnecessary transport and conveyance of material and equipment, and unnecessary motions and movement of people

According to Salem et al. (2006), there is a considerable waste in the construction projects which goes unnoticed. Previous studies (Senaratne & Wijesiri, 2008; Vilashini et al., 2011; Rahman et al. 2012) disclose that the workforce in the domestic construction industry is ignorant of these NVAAs that create waste and hinder construction performance. According to Koskela (2004), these wastes in the flow processes of construction such as 'non-conformance quality costs' consume a substantial amount of waste. Furthermore, he revealed the existence of these waste as 12% of the total project cost, poor material management results in 10-12% of the total labour cost, time used for NVAAs amounts to 2/3 of the total project time and lack of safety measures amounts to 6% of the total project cost.
A link exists between waste in a project and its cost. Waste is a major problem in the construction industry, and it amounts to 60% of the construction effort (Vilashini et al, 2011). A study focussing on the construction efficiency made by the National Institute of Standards and Technology in the United Kingdom indicates that 25-50% of waste relates to coordinating labour and managing, moving, and installing the material. Mossman (2009) has stated that 5-10% of the construction effort is for creating value, 30 -35% for supporting value creation and that 55-65% is wasted with much of the activity that supports value creation being logistics. Horman and Kenly (2005) have contended that as much as 49.6% of the construction operative time may be devoted to NVAAs. NVAAs have been identified as one of the problems negatively impacting on issues relating to variations. Waste that generates in the flow activities is recognized as a major disadvantage, which hinders performance and efficiency of constriction activities. Several authors, including Cornick (1991), Austin et al. (1994), and Koskela et al. (2001a) have identified these hindrances. They are poor communication, lack of adequate documentation, deficient or missing allocations, lack of co-operation between disciplines, unbalanced resource allocation and erratic decision making as the main causes for the poor performance of a building design process. According to Rahman (2012), every system contains waste. Vilashini et al. (2011) have disclosed that the analysis of the construction process indicates that construction activities can consist of 55% of Non-Value Adding Unnecessary Activities).

One-third of these activities result from factors under the control of management, such as rework and errors. Furthermore, Mahfuth at el (2019) identified two types of waste as operation waste and cultural waste. Operation wastes are rework, variation and negligence, unskilled labour, time restraint, poor communication, poor coordination between trades, and Inclement weather. The cultural wastes are lack of awareness, lack of incentives, lack of support from senior management, and lack of training. According to (Mahfuth at el 2019), waste can affect the success of construction projects in terms of cost, time, productivity, sustainability and environment. Construction waste management activities are inherent throughout the entire construction project life cycle from initial design to end/completion or demolition. Waste is classified into physical wastage on site but also on any form of inefficiency in productivity, work quality, handling and storage of materials, activity time and workers' movement. (Hwang et al., 2008), Elkhobar, Denanda and Trigunarsyah, 2011), (Katz and Baum, 2011). Further, they have revealed that the most significant categories of NVAAs are 'defects' and 'waiting.' Furthermore, Thilakarathna and De Silva (2014) identified that NVAAs occur to the extent of 59% throughout construction projects.

Most of the construction projects are highly specialized, complex, with broad categories of stakeholders, with lead-time depressed durations for commencement, design and completion (Bryant and College,2002). Simialrly, Hosseini, Nikakhtar and Ghoddousi (2012) states that the construction industry is one with large specialized areas and disciplines. Construction project delivery system consists of three domains; the contract, the project organization and the project operating system (Thomsen et al., 2010). Furthermore, they stated that the project operating system had been largely neglected and this situation contributes significantly to inefficiency and waste. When focusing on waste, our attention is on what is not needed for the process of activities. All construction activities can be divided into two categories, conversion activities which produce tangible products and flow activities which bind such conversion activities during the delivery process of the output (Senaratne

and Wijesiri, 2008). Waste that generates in flow activities is recognized as a major weakness which hinders performance and efficiency in the construction process flow. According to Vilasini, Neitzert and Rotimi (2014), there are several studies on process waste in construction, also stressed that individual waste in construction appears negligible, but if all this waste is added up, it can be substantial over time.

Construction projects have been identified to occur many injuries which lead to the suffering of people, unnecessary compensation costs, time overrun, productivity and efficiency reduction, material wastage and increased rate of employee turnover (Mahfuth at el 2019). No general trend concerning the outcome in terms of cost, quality, contract flexibility, avoidance of disputes, or construction time can be seen. (Johan Nystrom 2007). Furthermore, a lot of the criticism of the construction industry has also been focused on the inability to get the stakeholders of the project to engage cooperatively in the delivery of the client's objectives on time, cost and quality. Moreover, construction managers fail to execute projects efficiently. CMs have a significant role in creating and implementing strategies to deliver projects. Many researchers (Mosman, 2009; Horman and Kenley, 2005; Vilashini et al., 2011) have revealed that a major portion of time in construction is devoted to wasteful activities. These non-value adding activities are the major cause of schedule delays, cost overruns and other related problems in the construction process flow (Emuze and Smallwood 2011).

Hence, it can be concluded that there is a necessity for reducing these NVAAs, which destructively affect the productivity of construction and its value for money. Thus the value hindrance by the waste in the flow processes of construction is reasonably evident, and it indicates the necessity to implement a concept such as lean construction. The next section of this paper is dealt with LC and its implementation.

LEAN CONSTRUCTION (LC)

Overview of LC

LC is an innovative way to apply lean production principles to the construction industry to eliminate non-value adding activities in construction process flow (Koskela, 1992; Womack and Jones, 2003; Salem et al, 2006; Singleton and Hamzeh, 2011; Shang et al, 2012. The developing concept of lean construction is concerned with the application of lean thinking to the construction industry Rahman (2012) keeps an eye on the value-added element (conversion) as well as the non-value added elements (flow, delay, and errors) (Al-Aomar (2012). During the past ten years, there has been growing attention in investigating the extent to which the Japanese model of lean production can be applied in the construction industry among academics all over the world (Vilasini, Neitzert and Rotimi 2014).

LC assumes that construction is a kind of production process (Bertelson, 2004). The preliminary starting point for the approach is the claim that project teams are responsible for helping clients to decide what they want, not just doing what the clients tell them. Rahman (2012) has explored the key steps in the LC process. These are identifying client's budget, determining design criteria, target values and constraints. Lean construction is the continuous process of eliminating waste, focusing on the entire value stream, and pursuing perfection in the execution of a construction project. It also focuses on the way one activity can affect the next (Pinch, 2005). Work is structured throughout the process to maximize value and to reduce waste at the project delivery level. According to Rahman (2012), three features distinguish lean construction practice from conventional construction management. Firstly, LC focuses on reducing waste that may exist in any form in the construction processes such as inspection, transportation, waiting, and motion. LC also aims at reducing variability and irregularity so that material and information can flow in the system without interruptions. Last but not least, construction material is expected to be at the site only when it is needed. Mitropoulos and Tatum (2000) cited by Vilasini, Neitzert and Rotimi (2014) recommend a three-divided approach that

integrates contractual, organizational and operational aspects to deliver projects successfully. Therefore, it is significant to consider the construction project as operational aspects of the project delivery system with a lean perspective.

LC Implementation

The lean project delivery system emerged in 2000 from theoretical and practical investigations and is in the process of undergoing development in many parts of the world through experimentation. In recent years, studies have focused on the definition and design phase of projects, applying concepts and methods drawn from the Toyota Products (Barrald 2008). Ballard (2008) divides the lean project delivery system into four interconnected phases, i.e., project definition, lean design, lean supply, and lean assembly. Moreover, Ballard (2006 and 2008) has identified the lean design phase transforms the conceptual design of the project into a lean product and processes the design to be consistent with project scope and design criteria. Furthermore, he states that the lean supply module consists of the detailed engineering of the product design, the fabrication or purchasing of components and material, and the logistics of deliveries and inventories. Lean assembly ranges from the delivery of tools, material, and components to commissioning and project delivery to the client (Al-Aomar (2012). The reliable release of work between specialists in design, supply and assembly assures value is delivered to the customer and waste is reduced. According to Sacks et al. (2010), addressing sustainable issues such as economic, social, and environmental values as the requirement of an owner, 'Lean' may perform from project definition to its construction phase. Moreover, a lean delivery emphasizes a cost-effective and on-time handover with no delays or rejects or quality issues (Al-Aomar, 2012). According to Salvatierra-Garrido J. and Pasquire C. (2011), LC experience commonly connects construction practices with the Transformation-Flow-Value model of Koskela, where value is mainly delivered during the production process at the site. Consequently, most of the efforts have been made to satisfy the client's (as the paying customer) requirements. Bertelsen (2004) have argued that the clients represent interests from three main groups; owner, user and the society who value different things at different times through the life cycle of construction projects. 'Lean' changes the way the construction work is done through techniques and applies them to a new project delivery process (Vilashini, Neitzert & Rotimi (2014).

Several lean techniques have been developed for the manufacturing industry, and the implementation of these techniques in the construction process flow has been identified in the literature for the last two decades. The widely used lean techniques to provide more value with fewer resources are summarized in Table 1.

Table 1: The widely used lean techniques in Construction Flow Process

Ref	Lean Techniques	Sources
1	Last Planer System	Alarcon, L.F, Diethelm, S., Rojo, O. and Caldero, R., (2005, Al-Aomar R. (2012), Andersen B., Belay A M, and Seim E. A. (2012), Ballard, G., and Kim, Y.W. (2005) Ballard G. (2011), Salvatierra-Garrido J. and Pasquire C. (2011) Bae, J.W., and Kim, Y.W. (2007) Ballard G, (2008)
2	Just in Time	
3	3D Modelling	
4	Visualization	
5	Value Stream Mapping	
6	Reverse Phase Scheduling	

Ref	Lean Techniques	Sources
7	Huddle Meeting	Bertelsen, S. (2004) Cho, S, and Ballard, G., 2011 Christine L Pasquire, C. L., and Connolly, G.E. (2002) Ekanayake S. and Senaratne S. (2010) Genaidy A., Luehring M., Paez., O and Solomon, J.(2004) Hamzeh, F, Ballard G, Tommelein I D (2012), Howel, G. And Ballard G.,(1998) Jayasena H.S and wedikkara C. (2013) Koskela, L. (2004) Kalsaas B T (2012) Lean Examples in Construction, Report by the Construction Productivity Network, (2003) Luo, Y., Rilley D. R. and Horman M J. (2005) Mossman, A. (2009), Peng, W. And Pheng, S. (2010) Rahaman H A, Wang C, Lim I Y W (2012) Salem, O. and Zimmer E (2005) Salem O. Genaidy A., Luehring M., Paez., O and Solomon, J. (2004), Salem.O., Solomon.J, Genaidy, A. And. Luehring, M. (2005) Senaratne S. and Wijesiri, D., (2008) Report by the Construction Productivity Network, (2003) Tam V. W Y., Tam C.M., and William C.Y. N (2007) Thilakarathna N. and De Silva L. (2018) Tzortzopoulos, P. and Formoso, T. (1999) Vilashini, N, Neitzert, T R, and Rotimi, O. J (2011) Vilashini N. and Neitzert T R (2012) Zimina,D., Ballard, G., Pasquire, C.,2012 Belay A M, and Seim E A (2012),
8	Prefabrication	
9	Off-site Manufacturing	
10	Kaizen	
11	Five S	
12	Fail Safe Quality	
13	Target Value Design	
14	First Run Studies	
15	Relational Contracting	
16	Target Costing	
17	Set-Based Design	
18	Kanban Material Card	
19	BIM	
20	Total Quality Management	
21	Work Standardization	
22	Work Structuring	
23	Flow Charts	
24	Lean Production Philosophy	
25	Value Chain	
26	Increased Visualization	

However, several authors (Marhani, 2012; Ayarkkwa et al, 2012; Al-Nafil, 2013; Thilakarathna and De Silva, 2014; Sisbon and Eishennawy (2015); Harrison and Thurnell, 2015; Olnan and Abdulrahim, 2015; Habchi et al, 2016; Bajjou and Chafi, 2018) have explored that Lean construction implementation is slow. Moreover, LCI is still its infancy in most of the developed and developing countries such as Malaysia, UK, Libya, Sri Lanka, Moroccan, KSA and New Zealand for many reasons. Hence, it is vital to assess the reasons for the slow implementation of LC, and the next section presents the critical barriers for LCI and their relation to the psychology, which is the mind and behaviour of human.

PSYCHOLOGY IN LEAN CONSTRUCTION

The preliminary literature review presented above discussed the research problem as NVAAs and the suitable approach to the research problem is LCI. This section presents the literature findings of the psychology in LCI. Furthermore, the barriers for LCI are assessed and the evidence is constructed through the barriers to establish the link between psychology and the LCI.

Psychology

Psychology is the scientific study of behaviour and the mind ((Passer & Smith, 2015). Social psychology and personality psychology are the subfields of psychology's diversity. Personality psychology focuses on human personality with core personality traits and the way different traits relate to one another and influence behaviour. Furthermore, Passer & Smith (2015) stated that social psychology examines people's thoughts, feelings and behaviour about the social world. How people influence one another, behave in groups and form impressions and attitude. Cognitive psychology is the subfield of mental process, especially from a model that views the mind as an information processor such as consciousness, attention, memory, decision making and problem-solving. According to Howell and Ballard (1998) in the early stage of LC lean production is a new way to coordinate action that rests on a new mental model. Moreover, Nesensohn *et al* (2014) identified eleven key attributes lean construction, and four of them are directly related to the psychological perspective. They are lean leadership; actively encourage and drive individuals, way of thinking: a holistic approach of thinking, change; a context towards LC is intrinsic, and work environment; working conditions to encourage individuals and teams. People differ meaningfully in the ways they customarily think, feel and act.

Psychology in Construction

Chinyio and Taiwo (2016) suggest that construction projects require teamwork and proper integration for successful project execution and completion. Previous studies have implicated psychosocial factors as significant determinants of effective team behaviour (Brewer & Gajendram, 2011), progressive decision making, firm integrations, as well as strategic planning and innovativeness within the construction industry. However, the current built environment pedagogy does not provide a platform module in which the psychological perspective of all such factors is taught or examined. This psychological perspective cannot be overlooked within the reality of construction and manufacturing environment. We aim to design a multidisciplinary educational curriculum, tagged psychology in construction (Psycon) which will explore the various areas of human factor within the built environment as affected by psychosocial influences to create greater awareness of such factors to students as this will benefit their professional interactions with people. Furthermore, the current management practices show the recognition of the importance of the workforce is essential (Jong, Sim and Lew (2019). Moreover, it is proven that the workforce is essential to the construction industry.

Barriers in LCI

Some studies carried out by many types of research in various countries have identified the key barriers for LCI in the construction industry. Table 2 summarizes those barriers for LCI based on the critical literature review conducted for this study. Literature from 1999 to date informs us there are barriers to LCI in different perspectives such as technical, financial and human. Sarhan et al. (2018) deduced that barriers to LCI are similar to both developed and developing countries. The principal barriers are traditional practices, standardization, technological, financial and performance and

knowledge related. Table 2 indicates that most of the barriers are directly related to the mind and behaviour of people. Moreover, Jelodar *et al.* (2018) concluded that there is a lack of innovation drivers within the construction projects. Furthermore, Bajjou and Chafi (2018) have also stated that there are two categories, people, related barriers (55.1%) and organizational barriers (44.6%). Hence, it is evident that psychology is a key concern in LCI, and there is a link between psychology and LCI.

Table 2: The link between LCI and Psychology

Literature Reference	**Barriers in Lean Construction Implementation**	**Evidence to Psychology**
Tzortzopoulos and Formoso (1999)	there is a lack of interest among construction parties to sit for a weekly review meeting to solve the problems causing project plan failures	***interest***
Salem *et al.* (2005)	Changing mindsets and behaviour with lean thinking become a challenge and to eliminate this barrier; the contractor has to offer training and recognition.	***mindsets and behaviour***
Alarcon *et al.* (2006)	***Time***: the main difficulty being lack of time for implementing new practices in the projects, ***Training***: Lack of Training, ***Organization:*** Challenges to create organizational elements, ***Self-Criticism***: Lack of self-criticism to learn from errors and responding to deficiencies, ***Low understanding*** of the concepts, low use of different elements, inadequate administration, weak communication and transparency and ***lack of integration*** of the construction chain	***self-criticism: understanding integration***
Vilasini, Neitzert and Rotimi (2012)	Team members are to be interested in making changes, The unfamiliarity with lean concepts, Misunderstanding of Lean concepts, Challenges to create organizational elements, Lack of self-criticism to learn errors, responding to some deficiencies, Inadequate administration, Weak communication and transparency, Lack of integration of the construction chain, Negative attitude towards implementing new practices	***attitudes, interests, self-criticism***
Vilasini, Neitzert and Rotimi (2014)	To sustain a process improvement; team members to be interested in making changes, willing to extend their joint efforts, promote a culture of teamwork and problem-solving	***culture of teamwork***
Harrison and Thurnell (2015)	Cultural resistance to change to 5D BIM from traditional quantity surveying techniques within integrated project delivery	***resistance to change***
Ruan *et al.* (2016)	"People" as the main barrier, "they do not want to change from what they are," "cultural issues" create complications, "yet another burden on the workforce," common company philosophy, "thinking of senior management."	***people as the main barrier***

Khaba and Bhar (2017)	Lack of awareness and understanding of lean construction. A coherent philosophy is yet to be developed for lean construction. Resistance to change with a tendency to apply traditional management concepts. Lack of understanding customer needs, Cultural difference: organizational culture and professional motivation	***awareness understanding resistance culture motivation***
Guerriero *et al.* (2017)	A lack of integrated management tools in "lean management" in construction processes, data acquisitions relies on people treatment, and exclusively paper-based, data manipulation, practitioners involvement	***rely on people involvement***
Sarhan et al. (2018) ,	Organizational culture, Influence of traditional management practices, Lack of committed leadership of top management, Lack of clear job specification from the client, Lack of client and supplier involvement, End-user preference, Use of non-standard components, Slow decision making processes due to complex organizational hierarchy, Uncertainty in supply chain, Lack of support from government for technological advancements	***culture, influence commitment preference***
Bajjou and Chafi (2019)	Lack of knowledge about LC practices, Unskilled human resources, Resistance to change, Time and commercial pressure, Lack of commitment from top management, Culture and human attitudinal issues, Fragmentation and subcontracting, Insufficient financial resources, lack of government support, Fragmentation and subcontracting	***resistance to change pressure attitudes***

LCI in a psychological perspective

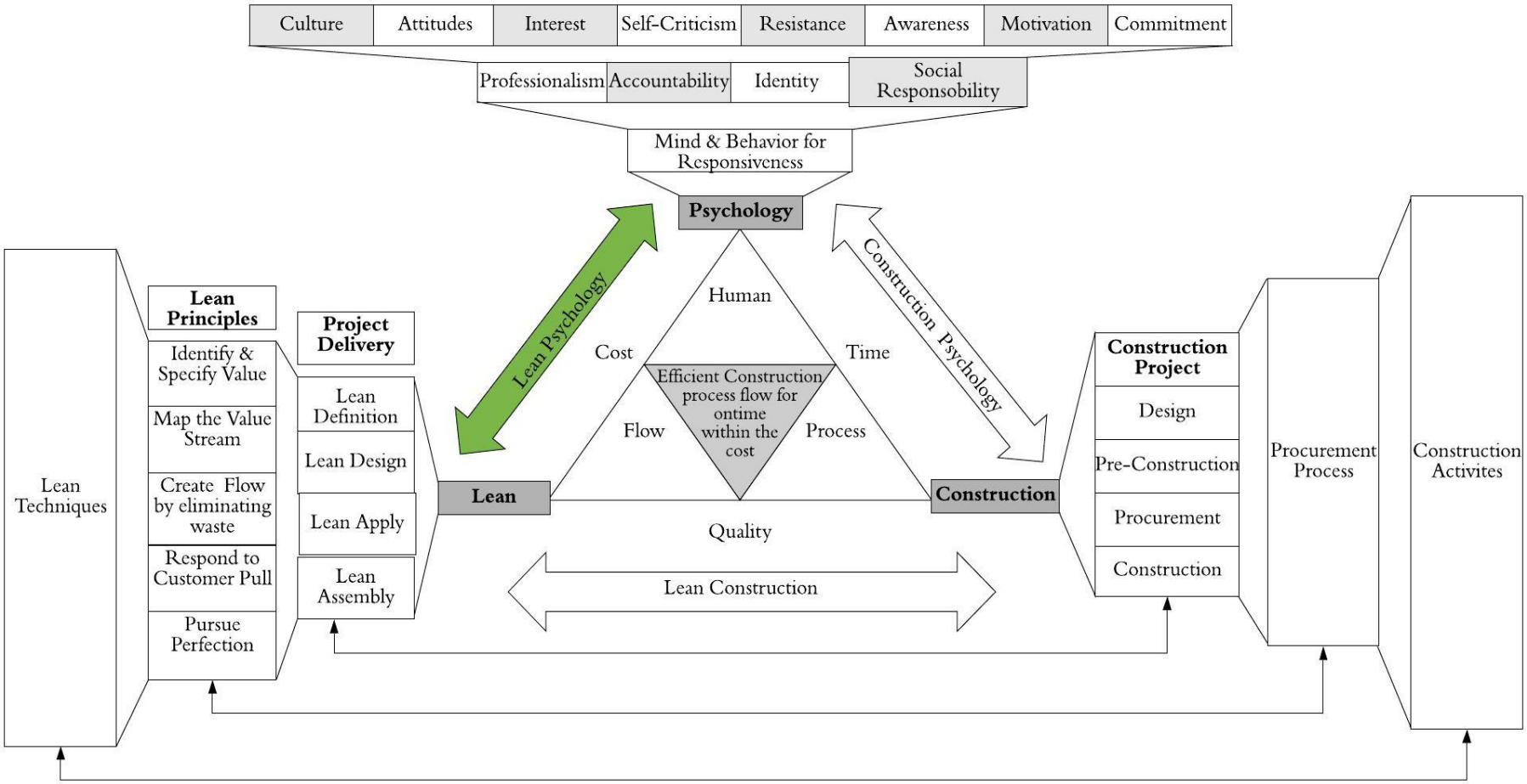
Literature confirms that LC is a new way of managing construction projects to improve its performance (Koskela, 1992; Womack and Jones, 2003; Salem et al, 2006; Singleton and Hamzeh, 2011; Shang et al, 2012; Vilasini, Neitzert and Rotimi (2014); Bajjou and Chafi (2018). However, the LCI is slow for many reasons and researchers have identified the barriers in implementing LC (Marhani, 2012; Ayarkkwa et al, 2012; Al-Nafil, 2013; Thilakarathna and De Silva, 2014; Sisbon and Eishennawy (2015); Harrison and Thurnell, 2015; Olnan and Abdulrahim, 2015; Habchi et al, 2016; Bajjou and Chafi, 2018). The findings in Table 2 illustrate how the human mind and behaviour is strongly linked with the barriers in LCI than other perspectives such as technology, organizational structure and cost. Hence, it is clear that psychology is a significant standpoint to find solutions for improving the LCI for sustainable benefits. When the LCI is improved, the project can complete on time within the budgets and can reap many benefits being sustaining long term in the construction industry (Senaratne and Wijesiri, 2008; Senaratne and Ekanayake, 2010; Vilasini, Neitzert and Rotimi, 2014). Table 2 shows us the subcategories of the canopy of Psychology as culture, attitude, interest, self-criticism, resistance, awareness, motivation and commitment. Therefore, this study aims to identify the suitable strategies to improve the LCI with professionalism, accountability, identity and social responsibility of the people involved in the LCI of construction projects to achieve their ultimate goals successfully. 'Lean Psychology' is the focus of future studies to suggest strategies to overcome the barriers in LCI. The conceptual framework developed based on this literature review is presented in the next section of this paper.

CONCEPTUAL FRAMEWORK

Literature informs us construction projects complete with cost and time overruns. One of the major reason is NVAAs, which incur costs and not do not add any value to the final construction project. Therefore, NVAAs need to be minimized for an efficient construction process flow to achieve the project deliverables of time, cost and quality. The LC has identified as one of the innovative approaches for managing projects by implementing different lean techniques developed and implemented in the manufacturing industry. There are many examples of the implementation of LC in construction projects from different countries over the last two decades. However, the background literature confirms that LCI is slow for many reasons. Hence the barriers for LCI were evaluated and tabulated in table 2 for further analysis. Moreover, these barriers were critically examined and identified that most of the barriers have a clear link to the mind and behaviour of people engaged in the construction process flow. All these literature findings were mapped to a conceptual framework as the last step of this paper.

A conceptual framework is a system of concepts, assumptions, expectations, beliefs and theories that support and indicates the research (Miles and Huberman, 1994; Robson, 2011). The conceptual framework developed through this literature review is presented in Figure 1. It has three main domains; lean, construction, and psychology. Lean is on the flow, construction is on the process, and psychology is on human. The centre of this framework is the output of the construction industry, which is a project with the efficient process flow to assure on time and within the cost. The iron triangle of construction project represents the cost, time and quality as project deliverables. Within this context, lean construction has been discussed in the literature for more than twenty years, and in the recent past, construction psychology emerged as discussed in this paper. 'Lean psychology' is a novelty concept to construction management sector, and it is about lean and psychology. This paper discussed that there is a clear link between psychology and the lean construction and the psychology in construction in the Lean Culture is the key driver for efficient construction process flow for on time and within the cost of a specific project. Furthermore, the framework emblems the psychological perspectives in Lean construction with culture, attitudes, interests, self-criticism, awareness, motivation and commitments. Moreover, this study will deeply look into professionalism, accountability, identity, and social responsibility as the next step.

Figure 1: A conceptual framework for improving construction process flow



CONCLUSION AND THE WAY FORWARD

Conclusion

The construction industry is suffering from low productivity, insufficient quality, time and cost overruns, poor safety, frequent disputes, lack of innovation, project asking so long and always exceeding the client's budget. Moreover, the construction sector has a wide range of activities that result in waste, which incurs costs and does not add any value to the final product. The traditional thinking of most of the construction-related organizations is on conversion activities, and flow activities and value considerations are ignored. Lean construction keeps an eye on the value-added element of the construction process (conversion) as well as the non-value added elements (flow, delay, and errors). The literature indicates that 'lean' minimizes waste and that lean techniques can be applied to minimize NVAAs in the construction projects. Lean is an innovative construction management approach which is linked closely to the overall life of a project ensuring its success. However, the background of this study indicates that Lean construction implementation in slow and is still its infancy in most of the developed and developing countries. Literature confirms that there are barriers to LCI in different perspectives and mind and behaviour of people who work in the construction industry is a key barrier for LCI. Moreover, when the barriers in LCI are further evaluated, it is evident that there is a link between Psychology and LCI. Finally, this paper suggested a conceptual framework to replicate the link between lean construction implementation and psychology.

The Way Forward

The ultimate aim of this study is to develop a framework for improving construction process flow by implementing lean construction practices which emblems a psychological approach to embrace the Lean Culture for long term sustainability. The objectives of the wider research project are to; identify the hindrance of the construction process flow, assess the LCI, map the reasons for slow LCI with psychological aspects and to develop a framework for improving the efficiency in construction process flow with lean psychology. The research methodology will be a mixed-method approach. A preliminary literature review to identify the link between LC and psychology was already done. The unit of analysis is "construction project," which completed recently. This research will continue with a survey and several cases studies and ending with experts' opinions to refine a framework for improving the process flow of construction activities with lean psychology.

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