

**FOSTERING LEAN CONSTRUCTION THROUGH
HUMAN CAPACITY BUILDING: AN EMPIRICAL
STUDY OF THE LARGE-SCALE CONTRACTORS IN
CONSTRUCTION INDUSTRY**

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Thesis submitted in partial fulfilment of the requirements for the
Degree of Master of Science (Major Component Research)

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February 2022

DECLARATION

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DEDICATION

*To my beloved husband, parents, brother
and the hidden pillars of my every
success.....*

ACKNOWLEDGEMENT

This dissertation is an outcome of much dedication and assistance received from many personnel and organisations, who contributed in different ways to complete this study. They have committed their valuable time and effort to ensure the success of this research. I take this opportunity to convey my gratitude to all of them.

First and foremost, I would like to express my heartiest gratitude to my supervisor Prof. Y. G Sandanayake for the utmost guidance, supervision and encouragement provided to me at all times to make this research a success. Her exemplary guidance since my undergraduate days has directed me in the right path as a researcher. My sincere gratitude is also extended to academic and non-academic staff members of Department of Building Economics for the immense assistance. I cannot forget the support received from my fellow researchers at the Research Room of Department of Building Economics.

I am also grateful to all the interviewees and subject matter experts who contributed for data collection of this research.

I wish to extend my sincere appreciation to Director Research and members of the Senate Research Committee of University of Moratuwa for providing funding to undertake this research under the SRC grant (SRC/LT/2020/04).

I am thankful to my beloved husband, parents and brother, for standing by my side throughout this journey. I am also grateful to my friends for their support.

ABSTRACT

Fostering Lean Construction through Human Capacity Building: An Empirical Study of the Large-Scale Contractors in Construction Industry

The construction industry practitioners are tending to implement lean based approaches for the successful project delivery instead of conventional project management approaches. Successful lean implementation in construction industry is severely impacted by human related challenges. Hence, human capacities are significantly necessary for the successful lean construction implementation. However, there is a lack of empirical investigation on lean enabling human capacities in construction industry. Therefore, this research was aimed to develop a model to foster lean construction through human capacity building by large-scale contractors in construction industry.

An in-depth literature synthesis was carried out to review on how to foster lean construction through human capacity building. The literature synthesis emphasised the human capacities necessary for successful lean construction implementation under seven sub human capacity categories namely knowledge, leadership, positive attitudes, work ethics, team work, critical thinking, and communication and strategies to build human capacities under four levels of individual, organisational, industry, and government. The data collection was carried out through the semi-structured interviews in three phases. Manual content analysis was used to analyse the obtained data.

Phase I of data collection identified several human related challenges of lean implementation including no commitment, knowledge level constraints, and lack of leadership on lean construction. Necessary human capacities to foster lean construction were identified for human resources of each hierarchical levels under aforementioned seven sub human capacity categories. Moreover, the advantages of human capacity building in lean construction implementation were investigated. Phase II of data collection has identified the strategies to build human capacities under four levels of individual, organisational, industry, and government. Finally, the collected data on human capacities and strategies were integrated in to a model and presented to three experts for validation and finalised the research model on fostering lean construction through human capacity building. This study makes several noteworthy contributions to the existing body of knowledge on human capacity building in lean construction and strategies to build human capacities to foster lean construction. Several recommendations on understanding potential advantages of human capacity building in lean implementation, and employing the developed framework on human capacity building in successful lean construction implementation can be made to the industry practitioners through this research.

Key words: Large-Scale Contractors, Lean Construction, Human Capacity Building, Human Related Challenges, Strategies

TABLE OF CONTENTS

DECLARATION	i
DEDICATION	ii
ACKNOWLEDGEMENT	iii
ABSTRACT	iv
TABLE OF CONTENTS	v
LIST OF FIGURES	xi
LIST OF TABLES	xii
LIST OF ABBREVIATIONS	xiii
LIST OF APPENDICES	xiv
1 INTRODUCTION	1
1.1 Background	1
1.2 Problem statement	4
1.3 Aim and objectives	5
1.4 Methodology	5
1.5 Scope and limitations	6
1.6 Chapter breakdown.....	7
1.7 Chapter summary	8
2 LITERATURE REVIEW	9
2.1 Introduction	9
2.2 Introduction to lean concept	9
2.2.1 Lean's seven waste management	9
2.2.2 Lean principles	10

2.2.3	Lean tools and techniques	11
2.3	Introduction to lean construction.....	14
2.3.1	Definition of lean construction.....	14
2.3.2	Lean implementation in global construction industry.....	15
2.3.3	Lean implementation in Sri Lankan construction industry	16
2.3.4	Drivers of lean construction implementation	17
2.3.5	Barriers of lean construction implementation	18
2.3.6	Strategies to overcome barriers of lean implementation in construction industry 20	
2.4	What is capacity building?	20
2.5	Introduction to human capacity building.....	21
2.6	Hierarchical Levels of Human Resources within a Construction Organisation.....	22
2.7	Human capacities necessary in construction industry	23
2.8	Human related challenges in lean implementation in construction industry.	24
2.9	Strategies to overcome human related challenges in lean implementation in construction industry	28
2.10	Lean enabling human capacities	29
2.11	Human capacities necessary for lean implementation in construction industry.....	29
2.12	Strategies for building human capacities to foster lean construction	34
2.12.1	Individual level strategies for building human capacities to foster lean construction	34
2.12.2	Organisational level strategies for building human capacities to foster lean construction	35
2.12.3	Industry level strategies for building human capacities to foster lean construction	36

2.12.4	Government level strategies for building human capacities to foster lean construction	38
2.13	Advantages in building human capacities necessary for fostering lean in construction industry	38
2.14	Conceptual model	40
2.15	Chapter summary	41
3	RESEARCH METHODOLOGY	43
3.1	Introduction	43
3.2	Research philosophy	43
3.3	Research process	44
3.3.1	Background study	46
3.3.2	Literature review	46
3.3.3	Research approach	46
3.3.4	Research strategy	47
3.3.5	Data collection	48
3.3.6	Data analysis	49
3.3.7	Chapter summary	49
4	RESEARCH FINDINGS AND ANALYSIS	50
4.1	Introduction	50
4.2	Phase I – Data Collection, Analysis and Findings	50
4.3	Human related challenges in lean implementation in Sri Lankan construction industry	53
4.3.1	Lack or no commitment to lean implementation	55
4.3.2	Lack of leadership skills	55
4.3.3	Lean related knowledge level constraints	56

4.3.4	Lack of knowledge sharing	56
4.3.5	Lack of lean initiation	56
4.3.6	Lack of motivation or encouragement of bottom level workers	57
4.3.7	Lack of accepting feedbacks from bottom level workers	57
4.3.8	Lack of listening to bottom level workers.....	58
4.3.9	Lack of communication.....	58
4.3.10	Resistance to change	58
4.3.11	Human attitudinal issues	59
4.3.12	Lack of active learning or self-learning	59
4.3.13	Lack of networking and collaboration	60
4.3.14	Lack of ability to engage with bottom level workers.....	60
4.3.15	Lack of team work in lean implementation.....	60
4.3.16	Illiteracy	61
4.3.17	Lack of lean ethics	61
4.3.18	Lack of curiosity in lean concept and its applications	61
4.3.19	Other Human Related Challenges	62
4.4	Human capacities necessary for lean implementation in Sri Lankan construction industry	63
4.4.1	Knowledge	65
4.4.2	Critical Thinking	67
4.4.3	Positive Attitudes	68
4.4.4	Leadership	69
4.4.5	Communication	70
4.4.6	Team Building.....	71

4.4.7	Work Ethics.....	72
4.5	Advantages in building human capacities necessary for fostering lean in Sri Lankan construction industry	73
4.6	Phase II – Data Collection, Analysis and Findings	78
4.7	Strategies for building human capacities to foster lean in Sri Lankan construction industry	78
4.7.1	Individual level strategies	84
4.7.2	Organisational level strategies	85
4.7.3	Industry level strategies.....	86
4.7.4	Government level strategies	87
4.8	Development of research model.....	88
4.9	Phase III – Validation of the Model	90
4.10	Summary	94
5	CONCLUSIONS AND RECOMMENDATIONS.....	95
5.1	Introduction	95
5.2	Overview of the research and conclusions drawn from the study.....	95
5.3	Contribution to the knowledge	99
5.4	Recommendations for industry practitioners	100
5.5	Further research directions	100
	References	101
	List of publications.....	119
	Appendix A: Summary table for human related challenged of lean construction implementation in Sri Lankan construction industry	120
	Appendix B: Human capacities necessary for lean construction implementation in Sri Lankan construction industry	123

Appendix C: Summary Table for Advantages of Building Human Capacities necessary in Lean Construction Implementation.....	126
Appendix D: Semi structured interview guideline – Phase I.....	128
Appendix E: Interview transcript – Phase I	134
Appendix F: Semi structured interview guideline – Phase II	141
Appendix G: Interview transcript – Phase II	148

LIST OF FIGURES

Figure 1.1	Chapter Breakdown	7
Figure 2.1	Conceptual Model.....	41
Figure 3.1	Summary of research process	45
Figure 4.1	Cognitive map of human related challenges in lean implementation of large-scale contractors in Sri Lanka	54
Figure 4.2	Cognitive Map of Human Capacities Necessary in Lean Implementation in Large-scale Contractors in Sri Lanka.....	64
Figure 4.3	Cognitive Map of Advantages of Building Human Capacities necessary in Lean Construction Implementation.....	74
Figure 4.4	Model to Foster Lean Construction Through Human Capacity Building in Large Scale Contractors in Sri Lankan Construction Industry.....	89
Figure 4.5	Revised Model to Foster Lean Construction Through Human Capacity Building in Large Scale Contractors in Sri Lankan Construction Industry	93

LIST OF TABLES

Table 2.1	Lean tools and techniques	12
Table 2.2	Definitions of lean construction	15
Table 2.3	Drivers of lean construction implementation.....	17
Table 2.4	Barriers of lean construction implementation.....	18
Table 2.5	Definitions of human capacity building.....	21
Table 2.6	Human capacities necessary in construction industry.....	24
Table 2.7	Human related challenges in lean construction implementation	25
Table 2.8	Human related challenges of lean implementation in different hierarchical levels	26
Table 2.9	Strategies to overcome human related challenges	28
Table 2.10	Human capacities necessary for lean implementation in different hierarchical levels.....	31
Table 4.1	Profiles of respondents of in-depth interviews	51
Table 4.2	Strategies to Build Human Capacities Necessary for Lean Implementation	79
Table 4.3	Profile of validators.....	90
Table 4.4	Strategies Revised During the Validation.....	90

LIST OF ABBREVIATIONS

CIDA	Construction Industry Development Authority
CPD	Continual Professional Development
ICTAD	Institute for construction Training and Development
IGLC	International Group for Lean Construction
JIT	Just in Time
LC	Lean Construction
LPS	Last Planner System
OECD	Organisation for Economic Co-operation and Development
SMC	Small and Medium Contractors
UK	United Kingdom
USA	United States of America

LIST OF APPENDICES

Appendix - A	Summary table for human related challenged of lean construction implementation in Sri Lankan construction industry.....	120
Appendix - B	Human capacities necessary for lean construction implementation in Sri Lankan construction industry.....	123
Appendix - C	Summary table for advantages of building human capacities necessary in lean construction implementation.....	126
Appendix - D	Semi structured interview guideline – Phase I.....	128
Appendix - E	Interview Transcript – Phase I.....	134
Appendix - F	Semi structured interview guideline – Phase II.....	141
Appendix - G	Interview Transcript – Phase II.....	148

1 INTRODUCTION

1.1 Background

High cost, low productivity, insufficient quality and lesser value for money have become the chronic problems of construction industry (Aslam et al., 2020). Hence, construction organisations have tended to accomplish competitive edge through significant improvements to the construction sector to achieve several objectives such as value addition, performance maximisation, waste minimisation, and peace in the built environments (Anerao & Deshmukh, 2016; Koskela et al., 2002; and Palaneeswaran et al., 2003). Among those new reforms, Lean Construction (LC) is one of the best practices and a management principle, which has been borrowed from the Toyota automobile production system in order to seek the waste minimisation, effort maximisation, and guaranteeing value for money to clients or end users (Dallasega et al., 2018; Pavnaskar et al., 2003). Moreover, as a response to the requirement of strategies to enhance the productivity, efficiency, and quality of the construction procedure in order to maximise the value for money, many construction organisations have been emphasised on embedding lean concept to its processes as one of the most prominent approaches (Ogunbiyi et al., 2014).

Koskela (1992), one of the masterminds in LC research, stated that lean concept is undoubtedly beneficial in both long and short term for industry practitioners to execute construction projects more efficiently. Moreover, many researchers such as Nahmens and Ikuma (2011), Ogunbiyi et al. (2014), and Le Roux et al. (2016) have emphasised both monetary and non-monetary advantages of adapting lean concept in construction industry. Key benefits of implementing LC comprise decreasing cost of construction, increase of the construction site safety, improvement of the quality of construction, reduction of project duration, increase of the productivity and customer satisfaction, and enhancement of the sustainable development idea of the project (Sarhan et al., 2018; Babalola et al., 2019; Aziz & Hafez, 2013). Waste minimisation or elimination is another major advantage, which has been highlighted by significant number of lean experts (Eriksson, 2010; Forbes & Ahmed, 2010; Marhani et al., 2012).

The implementation of lean in construction industry is not free from barriers. This fact is evident by the considerable number of research studies in several developed, developing and under developed countries across the world. Mostafa et al. (2013) categorised the barriers for sustainable lean implementation in to managerial, cultural, technical, governmental, and implementation related aspects. Lack of awareness and understanding on lean, lack of top management commitment, time and commercial pressure, and culture and attitudinal issues of human resources have been identified as crucial challenges for successful lean implementation in the context of United

Kingdom (Sarhan & Fox, 2013). Further, Johansen and Walter (2007) have emphasized the key factors related to the barriers of sustainable LC in Germany under the technological development, management and organisational issues. The absence of a lean culture in Chinese organisations has been identified as another set of crucial barriers to implement lean in the Chinese construction industry (Shang & Peng, 2014). The study further revealed six underlying factors that hinder the LC implementation as, (a) people and partner issues, (b) managerial and organizational issues, (c) lack of support issues, (d) culture and philosophy issues, (e) government issues, and (f) procurement issues in the context of China.

Moreover, Dulaimi and Tanamas (2001) have identified unwillingness to provide training and resources to adopt new systems, methods, innovations, unchanging cultural aspects, and specially the lack of required capacities in human resources as the significant barriers. The barriers impacting to successful LC implementation in developing countries have also been found similar as to the developed countries including deficiency in the commitment of senior management, lack of awareness on lean, and reluctance to adopt to the lean culture (Abdullah et al., 2009). When considering under developed countries, Bajjou and Chafi (2018) have emphasized lack of knowledge on LC, unskilled human resources, lack of management capabilities and insufficient finances as key challenging factors for successful lean implementation in construction industry.

In Sri Lankan construction industry, Ranadewa et al. (2019), Senaratne and Ekanayake (2011), and Thilakarathna and Senaratne (2012) have identified barriers for implementing lean principles as lack of time for lean implementation, not obtaining proper training on lean, challenge to create organisational elements, lack in self - learning through errors, low understanding of the concepts, lack in proper administration procedures, loop holes in communication chains, and ineffective integration of the construction chain. Further, Madanayake (2015) has assessed several barriers towards successful lean implementation and lack in commitment of the top management, deficiencies in awareness and understanding on lean concept, and financial issues were proven as significant barriers in Sri Lankan context. When considering the above barriers, it is clearly evident that the most commonly identified lean implementation barriers are related to the human aspects such as training, knowledge, skills and attitudes of workers, commitment and style of management and culture.

In this context, Bhasin (2012) emphasised that lean is not just a set of tools and techniques, but its heart is the people. Further, as per the author, the improvement of the knowledge, intelligence and the desire of human resources have the capability of directing the organisations to significantly achieve the continuous improvement. Hence, lean concept heavily relies on the knowledge and skills of the people and how

they respond to changes (Sawhney & Chason, 2005). Higher performance of construction projects can be guaranteed by combining both technical and human resources together effectively (Moore, 2002). According to Koskela et al. (2002), LC requires changes in individual behaviour and thus, building individual capacities will accelerate the lean implementation. Moreover, providing specific training for individuals as per the construction industry requirements has been emphasized as a strategy to build the particular lean capacities (Kululanga, 2012; Lopes & Theisohn, 2003; Karunasena & Amaratunga, 2016). This necessitates an in-depth investigation on the individual's impact on lean implementation in construction industry and lean enabling human capacities. Hence, successful lean implementation necessitates an extensive consideration on human capacity building.

Human capacities are focusing on developing skills, building relationships among individuals, knowing how, what and co-creation of understanding and meaning of the human resources (Enemark & Ahene, 2002). Organisation for Economic Co-operation and Development (OECD, 2012) highlighted human capacity as the knowledge, skills, and competencies, which requires to establish and achieve objectives. Furthermore, Matachi (2006) defined human capacity as an individual's willingness and ability to create goals and attain them using their own knowledge and abilities.

According to Kululanga (2012), capacity building for construction industry would be the contribution towards transformation, and change at individual, organisational, industrial and governmental levels. Individual contributions can be highlighted when assessing how human resources are equipped for the industry with proper education and training, as well as continual professional development (CPD) (Kululanga, 2012). In order to enhance several management aspects and ensure the sustainable of a building construction project, Enemark and Ahene (2002) highlighted the significance of human resources in terms of knowledge, skills, and positive attitudes. According to OECD (2012), individual level capacities include “soft capacities” such as the capacity to build relationships, trust and legitimacy and “hard capacities” such as technical, logistical and managerial skills. In the perspective of organisational, industrial, and governmental levels, capacity building focuses on a series of actions that is directing at supporting human resources development process in increasing knowledge, skills and understanding and developing attitudes to achieve the desired developmental change (United Nations Committee of Experts on Public Administration, 2006).

Ranadewa et al. (2018) highlighted that human capacity building has a significant impact on the successful lean implementation by Small and Medium Contractors (SMCs) and hence, the organisations must focus on the capacity development for sustainable lean implementation. However, a dearth of research on how to overcome the barriers of lean implementation through capacity building of human resources in construction industry can be identified in Sri Lankan context.

1.2 Problem statement

Delays, budgetary constraints and poor-quality standards can be identified as common constraints in construction projects. Hence, the conventional project management approaches address the aforementioned issues to some extent. Nevertheless, effectiveness of conventional approaches remains neutral, which does not provide solutions for the above problems. Hence, the significant numbers of construction organisations and industry practitioners are tending to implement lean thinking and lean based approaches for the successful project delivery (Aziz & Hafez, 2013). Several researchers such as Alinaitwe (2009); Aziz and Hafez (2013); Bashir et al. (2010); Bhasin (2012); Shang and Pheng (2014); and Thilakarathna and Senaratne (2012) have explored the barriers of lean construction implementation and possible solutions to overcome them in global context. In summary, most of the researchers such as Bashir et al. (2010), Common et al. (2000), Madanayake (2015), and Ranadewa et al. (2018) stressed lack of training, ineffective commitment of top management, lower levels of lean awareness, lack of lean culture, and lack in necessary capacities within human resources as human related barriers in lean implementation. Accordingly, Bhasin (2012) emphasized that lean thinking is fundamentally build upon not just the principles, tools or techniques but with the knowledge, intelligence and desire of the individuals. Furthermore, numerous researchers worldwide have emphasized the importance of emerging individual capacities to ensure the successful LC implementation (Kululanga, 2012; Lopes & Theisohn, 2003; Karunasena & Amaratunga, 2016; Koskela et al., 2002).

Ranadewa et al. (2018) have identified lack of individual capacities, cultural inertia, and insufficient training as major causes for the non-value adding activities of construction SMCs in Sri Lankan context. Further, Ranadewa et al. (2019) highlighted that human capacity building has the key potential towards the successful lean implementation in construction SMCs. Peoples' commitment, capability and capacity in applying lean concept are highly crucial in construction industry (Bhasin, 2012). Lack of emphasis on human capacities necessary to implement LC has further slowdown its implementation (Madanayake, 2015). Further, the positive impact of human capacity building towards successful lean construction implementation and hence the successful project delivery of large-scale construction projects in global context have also highlighted by several researchers such as Sawhney and Chason, 2005, Green et al. (2008). Thus, an investigation on human capacity building for successful lean implementation is a paramount research focus in construction industry. Ranadewa et al. (2019) have investigated the importance of human capacity building in SMCs to enable lean in Sri Lankan construction industry. However, their study was limited to construction SMCs, that have unique difficulties and way of operations. Further, the difficulties and capabilities of large construction

organisations may be different from construction SMCs in lean implementation. Moreover, there is a lack of evidence on the empirical investigation on lean enabling human capacities and strategies to build human capacities necessary for enabling lean in construction industry at large scale contractors. There is therefore a need to investigate:

“How to foster lean construction through human capacity building by large-scale contractors in construction industry”

1.3 Aim and objectives

The aim of this research is to develop a model to foster LC through human capacity building by large-scale contractors in construction industry.

In order to achieve this aim, following objectives have been formulated to:

1. Review the need of human capacity building for fostering lean in construction industry,
2. Investigate human related challenges faced by large-scale construction organisations in implementing lean concept in Sri Lankan construction industry,
3. Determine human capacities necessary for fostering lean by large-scale contractors in Sri Lankan construction industry,
4. Investigate the advantages of building human capacities necessary for fostering lean by large-scale contractors in Sri Lankan construction industry,
5. Propose strategies to build human capacities necessary for fostering lean by large-scale contractors in Sri Lankan construction industry.

1.4 Methodology

This study is aiming to develop a research model to foster LC through human capacity building in the Sri Lankan construction industry. This study was skewed towards the ontological assumption on idealism, which is socially constructed since the study valued the human interaction and epistemological assumption of the acceptable knowledge constitutes of insights and interpretations of people within research environment. The study took the value bound stance with respect to the axiology by considering that researchers are part of what is researched. As a result, this research study adhered to the interpretivism stance. Moreover, this study adopted a qualitative research approach.

An initial background study was carried out in order to identify the research gap and determine the aim, and objectives of the study. Later, an in-depth literature synthesis was carried out to review the human related challenges impacting to lean

implementation and necessary human capacities for successful lean implementation in construction industry. Further, the strategies for building human capacities to foster lean in construction industry. The literature synthesis was carried out by referring previous literature sources including books, journal article, conference proceeding, reports and official websites to name a few. The in-depth literature review led the researcher to achieve Objective 1 of the study. Subsequently, the empirical investigation of the study was conducted in three consecutive phases. The collected data in all three phases have been analysed using manual content analysis technique. Further, the collected data for human related challenges, human capacities necessary to be built, and advantages of building necessary human capacities have been summarised in to the cognitive maps.

In Phase I, the experts with previous experience in implementing lean in large-scale building projects were selected through purposive sampling. Accordingly, 25 subject matter experts including 15 industry practitioners from 03 construction projects done by large-scale contractors, and 10 other construction industry lean implementers, lean trainers and lean academics were selected in Phase I. The human related challenges faced by construction organisations, human capacities necessary to foster lean, and advantages in building human capacities for fostering lean by large-scale contractors in Sri Lankan construction industry were investigated to achieve Objectives 2, 3, and 4 in this phase.

During Phase II, data were collected on strategies to build human capacities to foster lean construction by large-scale contractors in Sri Lankan construction industry to achieve Objective 5. In this phase, ten lean experts including construction industry lean implementers, lean trainers and lean academics who were involved in phase I were interviewed at this stage as well.

In Phase III, lean enabling human capacity building model was developed by integrating research finding on necessary human capacities for successful lean construction implementation and strategies to build the identified human capacities for fostering lean by large-scale contractors in Sri Lankan construction industry. In order to achieve the research's aim, the developed model was validated by obtaining alternate explanations from three lean experts in the construction industry.

1.5 Scope and limitations

The study's focus was narrowed to propose strategies for developing the human capacities necessary to foster lean in Sri Lankan construction companies. Moreover, the study was limited to investigate the human capacities necessary to foster lean by large-scale contractors in Sri Lanka. According to service sector annual turnover and the Construction Industry Development Authority (CIDA) Sri Lanka registration for

construction contractors in Sri Lanka, the large-scale contractors can be categorised under whose annual turnover is higher than Rs. 300 million with CS1, CS2, and C1 grading (Ranadewa et al., 2018).

1.6 Chapter breakdown

Figure 1.1 depicts the chapter breakdown of this research study.

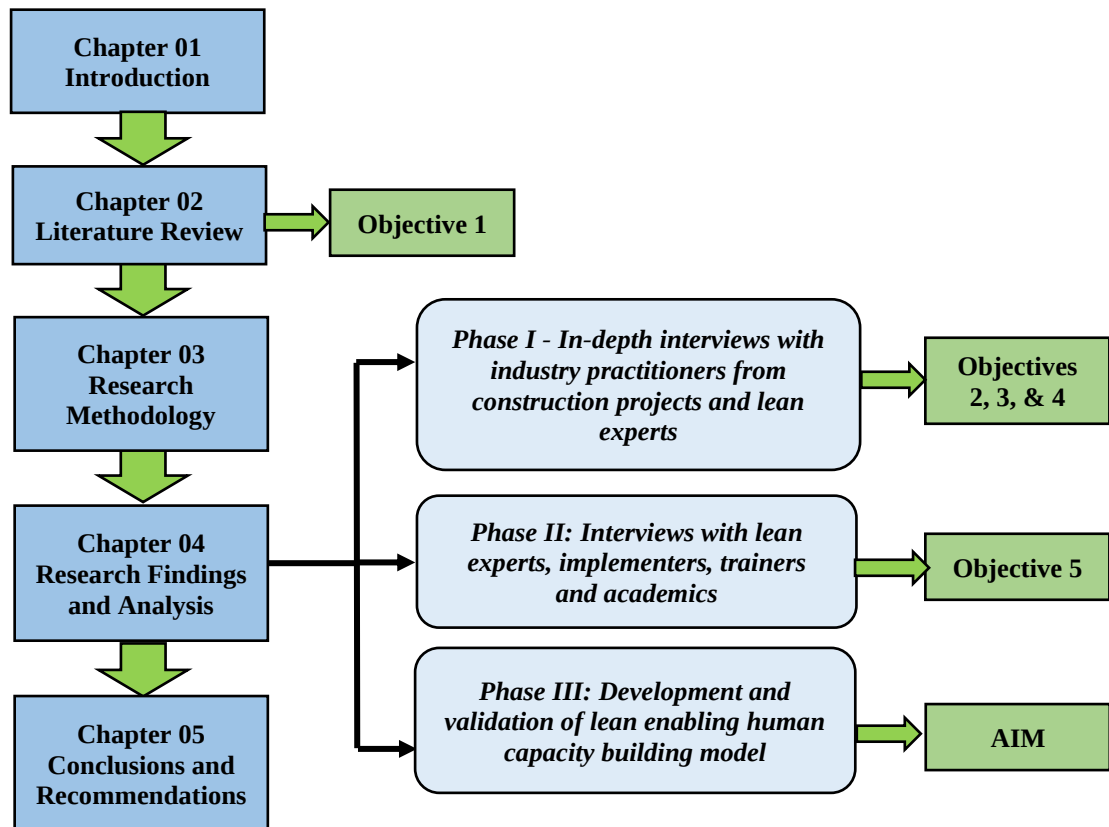


Figure 1.1: Chapter Breakdown

Chapter 1 – Introduction

Chapter 1 provides the research introduction along with the background study, research problem, aim, objectives, methodology, and scope and limitations of the research. The research aim of this study was established as to develop a model to foster LC through human capacity building by large-scale contractors in construction industry.

Chapter 2 – Literature review

Chapter 2 provides a literature review on the introduction to lean concept and LC, lean implementation in global and Sri Lankan construction industry, drivers and barriers of LC implementation, introduction to human capacity building for lean implementation and necessity of human capacity building to foster lean in construction industry. Further, challenges impacting the successful lean implementation related with the human resources of each hierarchical levels in Sri Lankan construction industry was identified through the literature review.

Chapter 3 – Research methodology

Chapter 3 provides the research process, research approach, research strategy, and data collection and analysis techniques used in this study to achieve the aim and objectives of this research.

Chapter 4 – Research findings and discussion

Chapter 4 provides the research findings collected through the three phases of this study. Chapter presents the data gathered in three phases mainly through in-depth interviews using semi-structured interview guideline and analysed with manual content analysis. It finally presents a lean enabling human capacity building model to foster lean by large-scale contractors in Sri Lankan construction industry.

Chapter 5 – Conclusions and recommendations

The study's overview and conclusions are presented in Chapter 5, as well as the research's contribution to the body of knowledge and industry practitioners. This chapter further provides the recommendations for future research.

1.7 Chapter summary

This chapter outlined the research study on fostering lean construction through human capacity building. The chapter initially presented a background of the study followed by research problem aiming at developing a model to foster LC through human capacity building by large-scale contractors in construction industry. Based on the research problem, the aim of developing a model on how to foster LC through human capacity building by large-scale contractors in construction industry was derived. The objectives were established to achieve the research aim. Further, the research methodology and the scope and limitations of the study were elaborated with the chapter breakdown.

2 LITERATURE REVIEW

2.1 Introduction

A comprehensive literature synthesis is presented in Chapter 2 on the definition of lean concept, lean principles, tools and techniques, drivers and barriers of lean implementation and approaches to eliminate those barriers. The chapter further reviews human capacity building and human capacities necessary in construction industry, human related challenges in lean implementation, human capacities necessary for lean implementation in construction and strategies to building human capacities fostering lean.

2.2 Introduction to lean concept

Lean thinking has been widely recognised by many industries worldwide as an innovative strategy and a powerful management system, which brings the significant improvements to the overall performance of an organisation (Meng, 2019). Hence, philosophy of achieving improvements of manufacturing in most economical way while focusing on the reduction of “muda” (waste) laid the foundation for lean concept and lean thinking (Womack & Jones, 2010; Womack et al., 2007). According to Akanbi et al. (2019), principles of lean concept is mainly aiming to eliminate production waste in order to decrease process cycles, and increase both quality and efficiency. Howell (1999) explained that lean manufacturing has the capability of optimizing the production system performances meanwhile meeting the requirements of end customers.

As proven in the literature sources, lean thinking has been initiated from the Toyota Car Manufacturing Company as novel approach to achieve a significant waste minimisation through the elimination of non-value adding, undesirable and complex activities in the production process (Ballard & Howell, 1998; Ballard, 2007; Howell & Abdelhamid, 2012; Tommelein, 2015). The lean manufacturing concept has been clearly defined as a system approach to manufacturing and other business process organisations, which involves waste reduction, continuous improvement and satisfying customer needs. Lean concept is basically focusing on the elimination of business processes that do not create any value while using large amount of resources, and identification and reduction of process cost (Ostapchuk et al., 2020).

2.2.1 Lean’s seven waste management

The primary focus of the lean manufacturing is to produce the final outcome of the product without generating any kind of waste (Jasti & Kodali, 2015). Furthermore, the

authors define waste as any activity, which does not add any value to the final product. According to Melton (2005), “Muda” is a Japanese term for the waste and it represent the activities, which does not add value to the customer. Considering the manufacturing industry, Ohno (1988) classified the waste into seven categories as a part of manufacturing process namely, over production, over process, waiting, transport, inventory, over processing, motion and defects. The aforementioned classification was presented to the industry practitioners by Womack and Jones (2010).

However, the eighth waste type namely “underutilised people” was added to the Ohno’s original list of wastes in lean manufacturing by few other authors (Duffy & Wong, 2013; Goodson, 2002). According to the authors, waste of underutilised people refers to not leveraging the potential individuals to the fullest and not using the creative brainpower of employees. Hence, the aforementioned eight types of wastes can be highlighted under the lean manufacturing concept.

2.2.2 Lean principles

The five principles of lean concept can be defined as identifying values, mapping value stream, flow, allowing customer pull, and pursuing perfection (Womack & Jones, 2003). These five principles of lean concept are briefly described below.

Specify value

Value is identified by the final customer’s requirements through tools such as value management, and quality function deployment (Lindfors, 2000). These will define characteristics that deliver client’s satisfaction (Garnett et al., 1998). Hence, the client requires to identify the product, which fulfils client intention, requirement and value for money (Ballard & Howell, 2004).

Identify and map the value stream

The value stream is a diagram that depicts all of the steps involved in producing process. Process mapping is a vital value stream technique for a very specific reason: to understand how value is built into the building product from the client's perspective (Fewings, 2013). Value stream mapping is a process flow chart that shows on which actions allow work to flow to the next operation. (Ballard and Howell, 1998).

Flows

Time, cost, and value are the characteristics of flows (Koskela, 2000). According to Koskela (2000), the essential units of analysis in the Lean concept are resources (labor, material, and construction equipment) and information flows. According to Dulaimi and Tanamas, (2015) two types of flows are available namely controllable and

uncontrollable. Further, the authors have emphasised that Materials or instructions from the warehouse or management are examples of controllable flows, whereas suppliers' provision of resources and design knowledge are examples of uncontrollable flows.

Pull

Pull recognizes the true need to deliver the product to the customer as soon as they need it on a strategic level (Bichneo, 2000). The manufacturing process forces the client into a lengthy development phase that is fraught with risk and uncertainty. (Dulaimi & Tanamas, 2001). The principle of pull suggests a decision where the ability to define quickly what the client needs from a production in relation to a particular business and subsequently customizing and deliver them more predictably when the client requires them (Garnett et al., 1998).

Perfection

This perfection concept entails producing exactly what the consumer requires in terms of quantity and quality at the correct time, at a fair price, and with the least amount of waste possible, with the ultimate aim of zero waste. (Bichneo, 2000). To achieve perfection, analyze what is being done, how it is being done, and how the experience and knowledge of all individuals involved in the processes may be used to improve and modify it (Dulaimi & Tanamas, 2015). As per the M. Goh and Goh (2019), lean principles are widely applying in both manufacturing and construction industries in order to improve the productivity, efficiency and eliminating wastes.

2.2.3 Lean tools and techniques

Many researchers and practitioners have introduced several lean tools and techniques in past such as value stream, 5S, just-in-time (JIT), visual management, preventative maintenance, kaizen, Kanban, Last Planner System (LPS), Poka-Yoke, concurrent engineering, value control, daily hurdle meetings and value stream mapping (Akanbi et al., 2019; M. Goh & Goh, 2019; Melton, 2005; Yadav et al., 2010). Adopting a lean approach within a company can have a significant impact on productivity, service delivery, and quality, resulting in significant cost savings (Akanbi et al., 2019). The key lean tools and techniques cited in past literature are summarised in Table 2.1

Table 2.1: Lean tools and techniques

Lean Tools & Techniques	References																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Just in Time (JIT)					X			X			X		X			X			X			X		X	X
Kaizen													X						X					X	X
Kanban													X			X			X	X		X	X	X	
5S	X		X	X						X			X						X	X			X		
Colour coding		X			X	X		X	X													X			
Poke Yoke	X		X	X						X													X	X	X
Heijunka							X				X			X			X								
Standard signboard		X			X	X		X	X																
Collaborative process mapping							X				X			X			X								
Big rooms												X			X			X			X				
Concurrent Engineering				X									X							X		X			
Visual control		X			X	X		X	X				X			X				X			X		X
Value systems												X			X			X			X				
Andon							X				X			X			X								
Value Stream Mapping	X		X	X						X			X						X	X		X			
Continuous improvements												X			X			X			X				
Total productive maintenance					X								X			X								X	
Last Planner System (LPS)	X		X	X						X			X							X		X		X	

Lean Tools & Techniques	References																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Daily hurdle meetings	X				X				X				X				X			X		X		X	
First run studies						X							X							X		X			X
References: [1] Banawi & Bilec, 2014; [2] Alhuraish et al., 2016; [3] Dineshkumar & Kathirvel, 2015; [4] Ngowtanasuwan, 2013; [5] Xu et al., 2017; [6] Ballard et al., 2002; [7] Bertelsen, 2004; [8] Issa, 2013; [9] Salvatierra-Garrido & Pasquire, 2011; [10] Li, et al., 2017; [11] Martens & Carvalho, 2017; [12] Pamfilie et al., 2012; [13] Ogunbiyi et al., 2014; [14] Sweis et al., 2016; [15] Dunlop & Smith, 2004; [16] Sivaraman et al., 2020; [17] Dombrowski & Mielke, 2013; [18] Aziz & Hafez, 2013; [19] Gupta & Jain, 2013; [20] Akanbi et al., 2019; [21] Ballard & Howell, 1994; [22] Zhang & Chen, 2016; [23] Melton, 2005; [24] Ahmed & Benson, 1999; [25] Russel & Taylor, 1999																									

According to the summarised tools and techniques given in Table 2.1, JIT, 5s, visual control, value stream mapping, and LPS can be identified among the top most lean tools and techniques cited by the researchers. Meanwhile, JIT, visual control, 5s, and daily hurdle meetings have been identified as most frequently used lean tools and techniques by Singh and Kumar (2020) in their systematic literature review on lean tools and techniques.

2.3 Introduction to lean construction

Lean Construction (LC) is a philosophy inspired by the Toyota Production System, which is based on lean manufacturing principles (Howell, 1999). International Group for Lean Construction (IGLC) introduced the term LC in 1993 to describe an approach of designing and carrying out construction activities to minimize waste in materials, time and efforts, with the aim of achieving maximum cost-effective value by considering the success and potential applications of lean manufacturing approach in construction projects (Pinch, 2005; Ballard, 2007). LC is a viable solution to many industry challenges, which causes results in outstanding performance enhancement. (Bhamu & Sangwan, 2014). The introduction of LC will cause significant change in the construction sector in order to meet the goals of sustainability within the built environment in effective social, economic, and environmental aspects. Even though the lean thinking was created to the manufacturing environment, many researchers worldwide such as Koskela (1992), Egan (1998), Howell (1999), Tommelein and Li (1999), and Vrijhoef and Koskela (1999) have studied the interpretation of lean concept for the construction process.

2.3.1 Definition of lean construction

LC focuses on meeting client expectations while minimizing resource waste, similarly with the other traditional approaches used in the building industry (Ogunbiyi et al., 2014). However, the difference between conventional and lean construction is that LC is based on production management principles, and it has better results in complex, uncertain, and quick projects (Ogunbiyi et al., 2014).

A construction project is viewed by LC as a temporary production system with three goals of completing the project, maximizing value, and minimizing waste. (Koskela, 2000). According to Akanbi et al. (2019), LC is about costs reduction by cutting waste, innovating by engaging people, and organizing the workplace to be more efficient, which offers new techniques of constructing sustainable projects. Moreover, the aim of LC has been highlighted as to enhance the continuous improvement, elimination of waste, increase the value for money, effective project management and supply chains, and improved communications chains (OGC, 2000). Several definitions of LC

provided by the researchers worldwide on its methodology and applications are summarised in Table 2.2.

Table 2.2: Definitions of lean construction

Definition	Author
Advantages of the new production philosophy in terms of productivity, quality, and indicators were solid enough in practice in order to enhance the rapid diffusion of the new principles	(Koskela, 1992, p. 9)
Lean construction is much like the current practice as the goal of better meeting customer needs while using less of everything	(Howell, 1999, p.2)
Lean is about achieving a balanced use of people, materials and resources. This allows companies to reduce costs, eliminate waste and deliver projects on time and it is not about trimming everything to the bone and squeezing more out of what is left	(Lim, 2008, p.13)
Lean construction is the practical application of lean manufacturing principles, or lean thinking, to the building environment	(Lukowski, 2010, p.66)
Lean construction is about managing and improving the construction process to profitability deliver what the customer needs by eliminating waste in the construction flow by using the right principle, resources and measure to deliver things right first time	(Yahya & Mohamad, 2011, p.3)
LC is a production management-based approach to project delivery - a new way to design and build capital facilities. Lean production management has caused a revolution in manufacturing design, supply and assembly. LC extends from the objectives of a lean production system - maximise value and minimise waste - to specific techniques and applies them in a new project delivery process	(Lean Construction Institute, 2012, p.29)
Lean construction is a production management strategy to ensure significant continuous improvement in business process performance by eliminating all wastage of time and other resources that do not add value to the product or service delivered to the customer	(Issa, 2013, p.698)

Considering the definitions provided by researchers, LC can be identified as production management-based approach, which employ the lean thinking to the construction process in order to achieve the balanced use of resources while reducing cost, eliminating waste, emphasizing continuous improvement and achieving value maximisation.

2.3.2 Lean implementation in global construction industry

Achieving of greater benefits through the implementation of lean concepts in construction industry worldwide is evident as Koskela (1992) put forward it in the first conference held by IGLC. Many literature sources are providing clear evidences on how the LC has been implemented in several countries worldwide and the benefits gained by the global construction industry with respect to the successful LC

implementation.

Based on the study of applying lean concept in construction by Egan committee, lean is successfully implementing in the construction industry of the United Kingdom (UK) (Mossman, 2009). According to “the Construction 21 (C21)” report, Singapore has adopted LC and practicing lean as one of the global trends on the management aspects (Dulaimi & Tanamas, 2001). Further, Silva and Cardoso (1999) identified the importance and complexity of lean thinking in the Brazilian construction sector in their studies. Furthermore, Johansen et al. (2002) discovered that the lean concept has penetrated in the Netherlands construction industry. As per the literature findings on the implementation of lean concept in the construction industry, many researches have been carried out in different countries such as for Chile (Alarcon & Diethelm, 2001), South Africa (Emuze & Smallwood, 2012), Turkey (Polat & Ballard, 2004) and United States of America (Nahmens & Ikuma, 2009). Hence, all these researches provide clear evidence that the lean concept has been successfully implemented within the global construction industry in a wide context.

2.3.3 Lean implementation in Sri Lankan construction industry

In the perspective of lean construction, Senaratna and Wijesiri (2008) stated that lean implementation in the Sri Lankan construction industry is acceptable and appropriate as a strategic alternative to avoid the major weaknesses regarding waste generation in operations. Nevertheless, lean implementation in the Sri Lankan construction industry is still in a developing stage and a proper awareness of the lean concept and the principles is essential for the successful implementation (Madanayake, 2015). Hence, the necessity of proper implementation framework for the lean implementation in Sri Lankan industry have been highlighted by Thilakarathna and Senaratne (2012). Further, Ranadewa et al. (2018) have highlighted lack of the capacity to successfully implement LC in SMCs in Sri Lanka.

Although Sri Lanka is in high time of lean implementation in construction industry, only the few research studies have been carried out on few areas such as investigating on the suitability and acceptability of lean construction aspects, application of lean construction principles and practices, and enabling lean among SMCs. Among those studies, Ekanayake and Senaratne (2010) and Vilasini et al. (2011) have emphasised that Sri Lanka is behind the successful implementation of LC. Hence, these findings have evidenced in the lack of capability for the successful implementation of lean concept in the Sri Lankan construction industry compared to the global context. Further, there is a lack of evidence on the empirical investigation on lean implementation in large scale construction projects in Sri Lanka.

2.3.4 Drivers of lean construction implementation

Identify the drivers that influence the lean implementation in the construction industry is essential since construction is a crucial sector of any economy and the use of lean concept in the industry seems to be essential to achieve the successful project delivery (Aigbavboa et al., 2016). Bayhan et al. (2019) has emphasised that some of the drivers, which are influencing on the lean implementation in the construction industry can be categorised under seven major groups, namely as financial, managerial, technological, workforce, culture, government and communication. Table 2.3 indicates drivers for lean implementation in the construction industry, which have been categorised under the aforementioned seven groups as stated by Bayhan et al. (2019).

Table 2.3: Drivers of lean construction implementation

Category	Drivers	References											
		1	2	3	4	5	6	7	8	9	10	11	12
Managerial	Top management commitment					X		X					
	Make lean awareness		X			X		X					
	Customer satisfaction			X	X				X				
Financial	Higher profit								X	X	X		
	Financial capability in lean implementation				X	X							
Technological	Awareness on Lean practices	X		X									
	Training on lean	X								X	X		
	Familiarity with lean tools	X				X		X					X
	Familiarity with new technologies					X		X			X		X
Workforce	Workforce efficiency				X		X			X		X	
	Lean qualified workforce		X		X	X					X		
	Effective human resource management				X	X							
	Lean concept consultancy				X			X					
Government	Government support and incentives						X			X	X		
Culture	Lean leadership support					X		X					
	Lean potential culture					X	X						
	Morale of employees					X						X	

Category	Drivers	References											
		1	2	3	4	5	6	7	8	9	10	11	12
Communication	Lean research groups	X					X				X		X
	Identification in clear roles of lean				X	X	X						
References: [1] Salem, Solomon, Genaidy, & Luegring, 2005; [2] Radhika & Sukumar, 2007; [3] Dave et al., 2013; [4] Kumar, 2013; [5] Leite et al., 2013; [6] Sarhan & Fox, 2013; [7] Jadhav et al., 2014; [8] Oyedolapo, 2014; [9] Demirkesen & Tommelein, 2016; [10] Almanei et al., 2017; [11] Howell et al., 2017; [12] Tommelein & Ballard, 2017													

According to Table 2.3 and as per the study conducted by Bayhan et al. (2019), clear understanding of lean practices by employees, adopting lean culture and commitment of management were significantly highlighted as important drivers. Accordingly, the effective human involvement and importance of human capacities for successful lean implementation have been highlighted by the researchers as significant drivers. Further, several literature findings evidence on the necessity of skills, capabilities and building the human capacities as some of the most important driving factors for LC implementation (Salem et al., 2005; Dave et al., 2003; Leite et al., 2013).

2.3.5 Barriers of lean construction implementation

Although many of the developed and developing countries are enjoying the advantages of lean implementation in the construction industry, most of the countries are still experiencing many barriers in lean implementation process (Bajjou & Chafi, 2018; Aigbavboa et al., 2016, Bayhan et al., 2019). Alves et al. (2012) identified three main challenges facing by LC academics and practitioners as below:

- the different meanings given to lean, its tools, and principles;
- the need to have academics and practitioners working collaboratively to better understand and implement major tools, concepts and systems, and;
- the constant need to engage people in meaningful learning experiences when lean is being taught and disseminated.

Further, Bayhan et al. (2019) have identified barriers for lean implementation and categorised them under seven groups as mentioned earlier under the drivers of lean implementation. Table 2.4 summarises the barriers for lean implementation identified by past researchers.

Table 2.4: Barriers of lean construction implementation

Category	Barriers	References											
		1	2	3	4	5	6	7	8	9	10	11	12
Managerial	Traditional management approaches	X	X	X			X	X		X			

Category	Barriers	References											
		1	2	3	4	5	6	7	8	9	10	11	12
	Lacking top management leadership	X	X	X	X	X	X	X	X		X	X	
	Poor resource management		X		X	X	X			X	X		
Financial	Market conditions	X			X		X			X	X		
Technological	Occur additional cost	X			X		X			X	X		X
	Lack of awareness on lean	X	X	X		X	X	X	X	X	X	X	
	Lack of technical sense	X			X		X			X	X	X	X
	Lacking modern technology using	X	X	X		X		X			X		X
	More time consuming					X				X	X		
Workforce	Issues in stakeholders										X		
	Employees resistance to new concepts		X	X		X		X			X		X
	Lack of other parties' involvement	X	X	X	X	X		X			X		X
Government	Lack of Knowledge by government and government support	X		X		X	X		X		X	X	
Culture	Employee resistance to change						X	X	X		X		
	Non-adaptation of organisational culture	X	X		X	X	X	X	X		X	X	X
Communication	Ineffective communication chains	X		X	X	X	X			X	X	X	
	Stakeholder issues in communication			X			X		X				
References: [1] Dulaimi & Tanamas, 2001; [2] Johansen & Walter, 2007; [3] Abdullah et al., 2009; [4] Alinaitwe, 2009; [5] Ayarkkwa et al., 2012; [6] Sarhan & Fox, 2013; [7] Devaki & Jayanthi, 2014; [8] Shang & Sui Pheng, 2014; [9] Bashir et al., 2015; [10] Olamilokun, 2015; [11] Omran & Abdulrahim, 2015; [12] Ranadewa et al, 2018													

According to the study conducted by Bayhan et al. (2019) with reference to the aforementioned barriers in Table 2.4, managerial barriers including lack of top management support and workforce related challenges including misperceptions on lean practices, lack of integrated change control and lack of understanding of workers were highlighted as critical barriers. Sarhan and Fox (2013) emphasised that the barriers to LC implementation in the UK construction industry are related to cultural perspectives. The significant cultural barriers refers to the lack of lean awareness and understanding, lack in commitment of top management and cultural and human attitudinal issues. In summary, complications of lean implementation are mainly driven by workforce, cultural, managerial, and technical related barriers, which has also been evident by the research study of Flinchbaugh (1998).

2.3.6 Strategies to overcome barriers of lean implementation in construction industry

Various solutions have been identified by the lean experts all over the world in order to address the barriers of lean implementation in construction industry. Ravikumar et al. (2016) have highlighted that maximisation of human resource utilisations as a solution for lack of the party's involvement in the lean implementation process and specifically, the lack of the involvement of skilled people. Moreover, Belhadi et al. (2016) emphasized the early positioning of lean culture towards the employees of the organisation through training programmes and enhancement of mindfulness and involvement of all employees on LC principles would be a better solution to overcome the barrier of lack of human capacities for lean implementation. According to Belhadi et al. (2016), the higher commitment and the effective participation of management level employees of an organisation will be highly impacting the elimination of management related challenges of lean construction implementation. Harness the managerial involvement of the construction organisation in order to align the lean objectives with the strategic goals of the company has been highlighted as another strategic solution to overcome the barriers of lean implementation (Achanga et al., 2006). In order to avoid the lack of skilled and unskilled labours to successfully implement LC within a construction organisation, Rymaszewska (2014) has emphasized the importance of standardization of work procedures and reinforcement of communication procedures. Moreover, the author mentioned that this will enhance the successful implementation of lean concept by eliminating the barriers of lean implementation.

When strategies to overcome the lean implementation barriers are reviewed, it was evident the importance of the effective involvement of human resources as mentioned above. Among those strategies, majority are related to capacity building such as early deployment of lean culture, enhancement of lean awareness and involvement of employees, higher commitment and the effective participation of management, standardization of work procedures and reinforcement of communication procedures. This necessitates the requirement of focussing on capacity building concept in terms of lean implementation in construction industry and hence, the next section elaborates the concept 'capacity building'.

2.4 What is capacity building?

The term capacity highlights the abilities, skills, knowledge, learning attitudes, values, relationships, behaviors, motivations, resources, and conditions that enable individuals, organizations, institutions, and systems to carry out functions in an effective, efficient, and innovative manner in order to achieve their development goals

(Carson, 2005; Kululanga, 2005; CIDB, 2002). Thus, capacity building comprises several approaches and strategies to enhance performance. The majority of indigenous construction organizations in developing nations lack capacity and, as a result, are unable to meet the demand for construction work (Didibhuku & Mvubu, 2008). According to CIDB (2002), capacity building in the construction industry is a deliberate and managed process that optimizes the construction industry's contribution to meeting national construction demand, promoting national social and economic development objectives, industry performance and competitiveness, and improved value to clients and society (Kululanga, 2012). According to the author, capacity building in any developing country is primarily about "change and transformation" through contributions at the individual, organizational, industrial, and state levels. Literature review in the previous section in terms of the implementation of LC provides the need to focus on the capacity building with respect to the individual level. Hence, the next section specifically focusses on human capacity building for the successful implementation of lean concept in construction industry.

2.5 Introduction to human capacity building

Individual employee contributions to capacity building refer to how employees are equipped for the industry through relevant education and training, as well as their ongoing professional growth (Kululanga, 2012). Hence, this can be identified as human capacity building within the development process of an organisations. Further, Loosemore et al. (2003) emphasized that the individual levels including unskilled, craft, managerial, professional and administrative workforces and every individual in each human resource category need to be developed in terms of human capacities.

Matachi (2006) has defined human capacity as the ability and willingness of an individual to establish and achieve the objectives using the own knowledge and skill levels. Human capacities are focusing on skill development, building stronger relationships, knowing how, knowing what and co-creation of meaning and understanding (Enemark & Ahene, 2002). Further, the authors identified human resources towards the sustainable long-term strategy to develop and manage several areas of an organisation in terms of skills, personal and group attitudes, and knowledge. Many researchers worldwide have provided definitions for human capacity building as summarised in Table 2.3.

Table 2.5: Definitions of human capacity building

Definition	Author
"...the practice of providing people with the knowledge, expertise, and opportunity to access information, knowledge, and training that enables them to perform effectively"	(UNDP, 1997, p.5)

Definition	Author
"... the process by which an individual, irrespective of sex, are provided with the expertise and understanding they need to perform effectively and efficiently in their different callings"	(Azikwe, 2008, p.19)
"...refers to activity to generate knowledge, skills, and expertise to improve the thinking ability that may assist in increasing productivity and sustenance"	(Nell & Napier, 2005, p.385)
"...capacity is a person's ability to do something to achieve the goals, resources, behaviour, motivation, relationships, and conditions that allow individuals, firms, sectors and the broader system to carry out their functions and attain development objectives set forth from time to time"	(Milen , 2006, p.4)
"...individual capacity as knowledge and skills to set and achieve objectives"	(OECD, 2012, p.16)

Considering the definitions given in above table, human capacity building can be identified as a process of building knowledge, skills, understanding, thinking ability and expertise of individuals irrespective of gender in order to carry out the functions and achieve the specific objectives efficiently and effectively. Prior to focus on the human capacities necessary in construction industry, the next section specifically focuses on the different hierarchical levels of human resources available within a construction organisation.

2.6 Hierarchical Levels of Human Resources within a Construction Organisation

Generally, the human resources can be considered as the most valuable asset in a particular company irrespective of the organisation type (Anumba et al., 2002). According to Anumba et al. (2002), the available human resource hierarchical levels within an organisation are depending on the type and the environment, which the organisation operates. Accordingly, the several human resource hierarchical levels can be identified within a construction organisation in accordance with the division of labour in to particular tasks and co-ordination among them (Mintzberg, 1975). Therefore, considering the different types of organisational structures including traditional and modern structures, different hierarchical levels of human resources have been identified in the previous research studies (Senior, 1997; Jones et al., 1998).

As per the functional structure proposed by Senior (1997), four human resource hierarchical levels have been highlighted including employees from three managerial levels and a bottom level worker. According to the classification of Senior (1997), three managerial levels have been introduced including top management level consist with senior director board, middle management level including project managers and

site managers, and operative management level including site supervisors, work scheduling officers. Further, skilled and unskilled level workers have also been identified including masons, joiners, electricians, and labours (Senior, 1997). Moreover, a division of five human hierarchical levels have been identified by the Concrete Construction Groups, Australia. According to their company profile, the availability of human resources from several hierarchical levels have been emphasised including on-site labour, administrative and operative level workers, and employees from senior management levels (Concrete Construction Group, 1997).

Considering the aforementioned divisions highlighted in the previous literature, the human resources hierarchical levels in construction organisation have been identified under five hierarchical levels as mentioned below.

- Senior Management Levels
 - Top level management
 - Middle level management
 - Operative level management
- Administrative and operative level employees
- Skilled and unskilled level workers

Accordingly, the above identified human resources hierarchical levels would be used as a basis to identify the human related challenges and human capacities necessary in lean construction implementation and strategies to build the necessary human capacities both in literature synthesis and empirical investigation.

2.7 Human capacities necessary in construction industry

Human capacities are making an enormous difference in the performance of construction industry of any country and hence, the human resource development is a crucial factor for a developing country (Ofori, 2015). Although some researchers highlighted the necessity of having production capacities, raw materials, financial resources and distribution channels for facing the competitiveness in construction industry, having only the above are not sufficient for organisational success (Mishra, 2018; Fugar et al., 2013; Adoko, 2010). Human capacities necessary in construction industry are related to several factors, which influence the productivity performance such as degree of competence and specialisation, motivation, team work and communication (Durdyev et al., 2018). According to Adoko (2010), several capacities of human resources including knowledge, skills and competencies, and the synergy between human resources are the key assets for achieving the competitive advantage in construction industry. Table 2.6 summarises the human capacities that are necessary in construction industry for successful project delivery.

Table 2.6: Human capacities necessary in construction industry

Human Capacities required in Construction Industry	References										
	1	2	3	4	5	6	7	8	9	10	11
Knowledge	X			X					X	X	X
Technical competence			X		X	X		X			X
Managerial competence	X				X			X			
Organisational competence						X	X	X			
Capacity of building relationship	X						X				
Previous experience			X					X			X
Innovative thinking		X			X	X			X		
Self-motivation			X								X
Self-commitment					X	X					
Attitudes and values			X			X					
Appropriate training		X				X		X	X	X	X
References: [1] Manley, 2008; [2] Ogunbiyi et al., 2014; [3] Weng Lou & Alshawi, 2009; [4] Yu & Yang, 2016; [5] Kamsaris, 2011; [6] Druker et al., 1996; [7] Ofori, 2015; [8] Kululanga, 2012; [9] Love et al., 2001; [10] Marimuthu et al., 2009; [11] Tamkin et al., 2004											

As per the above table, several researchers worldwide have emphasised the knowledge, technical and managerial competencies, appropriate training, and innovative thinking as the major human capacities required in construction industry. Further, human capacities such as organisational competencies, previous experience, self-motivation, and attitudes have been emphasized by some researchers as mentioned in Table 2.6.

2.8 Human related challenges in lean implementation in construction industry

Many researches have been carried out in various regions in order to identify the factors that can affect the successful lean implementation and categorised the highlighted challenges under several groups. According to Bashir et al. (2015), challenges can be classified in to six categories namely management, educational, governmental, financial, technical and human attitudinal challenges. Among the above-mentioned categories, human related issues are one of the major categories, which can highly impact the successful implementation of LC (Howell, 1999). Human related challenges in lean implementation in construction industry identified by the researchers are summarised in Table 2.7.

Table 2.7: Human related challenges in lean construction implementation

Human Related Challenges	References																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Lack of cooperation by workers			X		X		X	X	X	X			X							
Poor understanding of client's brief						X			X	X		X		X			X			X
Misconceptions about lean practices		X					X	X		X	X	X	X	X	X	X	X	X		X
Lack of committed leadership					X	X		X	X		X	X		X	X		X			X
Lack of team work						X			X	X										
Lack of self-criticism						X		X	X									X		
Poor house-keeping							X			X										
Fear of unfamiliar practices			X						X				X	X						X
Unskilled human resources	X			X			X				X	X	X				X			X
Issues in human attitudes	X					X			X											
Lack of top management commitment	X				X						X	X	X	X	X		X			X
Changing employees working culture	X	X			X				X		X	X	X	X		X		X		
Lack of lean awareness and understanding	X	X		X	X				X		X	X	X	X	X	X	X	X	X	X
Unwillingness to adopt new systems			X	X									X	X		X		X		
Lack of knowledge	X	X		X	X						X	X	X	X	X	X	X	X	X	X
References: [1] Sarhan & Fox, 2013; [2] Bashir et al., 2015; [3] Johansen & Walter , 2007; [4] Abdullah et al., 2009; [5] Ayarkkwa et al., 2012; [6] Alarcon et al., 2002; [7] Mossman, 2009; [8] Suresh et al., 2012; [9] Common et al., 2000; [10] Cua et al., 2001; [11] Dulaimi & Tanamas, 2001; [12] Olamilokun, 2015); [13] Bajjou & Chafi, 2018; [14] Sarhan et al., 2018; [15] Shang & Sui Pheng, 2014; [16] Omran & Abdulrahim, 2015; [17] Alinaitwe, 2009; [18] Devaki & Jayanthi, 2014; [19] Salem et al., 2005; [20] Kanafani, 2015																				

According to Table 2.7, many researchers have highlighted the significant impact of lack of cooperation by workers, misconceptions about lean practices, lack of committed leadership, unskilled human resources, lack of top management commitment, changing employees working culture, lack of lean awareness and understanding, and lack of knowledge on lean practices, on the successful lean implementation. Further, it can be observed that some of the literature findings highlight that poor understanding of client's brief, lack of team work and self-criticism, poor house-keeping, fear of unfamiliar practices, human attitudinal issues, and unwillingness to adopt to new systems are also making a considerable impact as a challenge towards lean implementation in global construction industry.

More comprehensively, Lodgaard et al. (2016) have emphasized that human resources of different groups at different hierarchical levels are experiencing different types of challenges in the successful lean construction implementation. Accordingly, the human related challenges of lean construction implementation were reviewed in the perceptions of management levels including top management level, middle management level, operative management level, administrative and operative employees, and skilled and unskilled workers. Table 2.8 summarised the human related challenges identified from the literature synthesis.

Table 2.8: Human related challenges of lean implementation in different hierarchical levels

Human Related Challenges		References
Managerial Level Staff		
Top Level Management		
1	Lack of commitment	(Chesworth, 2015)
2	Lack of leadership skills	(Chesworth, 2015)
3	Lack of awareness	(Bashir et al., 2015)
4	Lack of knowledge and experience sharing	(Chesworth, 2015)
5	Lack of interest in implementing new concepts	(Torp et al., 2018)
6	Lack of feeling urgency to change	(Mann, 2014)
7	Lack of proper backing support to implement new concepts	(Mann, 2014)
8	Lack of proper communication from top management to bottom levels	(Torp, et al., 2018)
9	Lack of long-term forecast of lean benefits	(Bashir et al., 2015)
Middle Level Management		
10	Lack of committed training	(Datta, 2012)
	Lack of leadership skills	(Chesworth, 2015)
11	Lack of incentives	(Bashir et al., 2015)
12	Mis-conceptualisation of lean construction tools	(Kalsaas et al., 2009)
13	Lack of clear definition of roles and responsibilities	(Cerveró-Romero et al., 2013)
14	Delaying in communication (eg: delaying in providing planning information)	(Gao & Low, 2014)

Human Related Challenges		References
Operative Level Management		
15	Lack of incentives	(Bashir et al., 2015)
16	Lack of proper communication towards skilled and unskilled workers	(Bashir et al., 2015)
17	Lack of clear definition of roles and responsibilities	(Cerveró-Romero et al., 2013)
18	Lack of trust and abilities	(Gao & Low, 2014)
19	Difficulty to adapting lean culture	(Green et al., 2008)
20	Existing the role of traditional authoritative style	(Bresnen et al., 2005)
Administrative Level Employees		
21	Higher complexity to practice lean in administrative activities	(Bashir et al., 2015)
22	Long implementation time	(Bashir et al., 2015)
23	Reluctance to engage in an involvement-based leadership	(Bygballe & Swärd, 2014)
24	Mis-conceptualisation of lean construction tool	(Bashir et al., 2015)
25	Communication issues	(Gao & Low, 2014)
Skilled and Unskilled Level Workers		
26	Lack of proper training	(Cerveró-Romero et al., 2013)
27	Lack of knowledge and understanding	(Mann, 2014)
28	Resistance to change in working culture	(Bashir et al., 2015)
29	More time consuming to train and make understand workers on lean practices	(Barbosa et al., 2013)
30	Misconceptions about lean practices	(Bashir et al., 2015)
31	Lack of cooperation by workers	(Alarcon et al., 2002)
32	Lack of teamwork	(Common et al., 2000)
33	Not giving any rewards besides normal wages	(Bashir et al., 2015)
34	Lack of involvement of construction workers	(Brady et al., 2011)

Table 2.8 demonstrates that human related challenges to lean implementation are different in nature across hierarchical levels of an organisation. Since human resources from different hierarchical levels have to perform different functions, roles and responsibilities, the nature of human related challenges can be differentiated. When considering the managerial level staff, some of the human related challenges such as lack of commitment, lack of leadership skills, lack of proper communication from top management level to bottom, lack of clear definition of roles and responsibilities can be seen as similar in nature for all levels of managerial staff. Further, the existing literature sources highlights the lack of knowledge, skills, competencies, corporation, and involvement of skilled and unskilled workforces of a construction industry as a major human related concerns impacting towards successful lean construction implementation. Unless the attention pays to the human related challenges of different human resource groups of different hierarchical levels, the efforts to implement lean and overcome challenges would be difficult (Lodgaard et al., 2016).

2.9 Strategies to overcome human related challenges in lean implementation in construction industry

The challenges that have been identified with reference to the successful lean implementation in construction industry are necessary to be addressed in order to achieve a smooth implementation of lean concept and realise expected benefits. Accordingly, the solutions that have been put forwards by several researchers worldwide have been summarised in Table 2.9.

Table 2.9: Strategies to overcome human related challenges

Strategies to Overcome Human Related Challenges	References
Organisations need to engage staff in learning process	Bashir et al. (2015) Karim & Arif-Uz-Zaman (2013)
Ensure the confidence within employees regarding the new approach	Bashir et al. (2015) Sarhan et al. (2018)
Ensure to reduce the fear regarding the misconceptions of LC	Bashir et al. (2015) Karim & Arif-Uz-Zaman (2013)
Top management need to be fully involved in the implementation procedures	Bashir et al. (2015) Sarhan et al. (2018) Bakas et al. (2011)
Ensure that entire staff is putting the continued effort in lean implementation	Bashir et al. (2015)
Ensure the higher involvement of whole staff in implementation and suggestion making	Bashir et al. (2015), Bakas et al. (2011)
Adopt training programmes for workers to make aware about lean practices	Shang & Peng (2014) Sarhan et al. (2018) Ahmed et al., (2019)
Establish new government policies to encourage lean practices	Bashir et al. (2015)
Avoid sudden cultural changes and instead, moving for gradual implementation procedures	Bashir et al. (2015) Belhadi et al. (2016)

The above table summarised various solutions put forwarded by many researchers with reference to the human related challenges, which are hindering the smooth implementation of lean concept within the global construction industry. The aforementioned solutions have been highlighted with respect to the different contexts. Accordingly, it can be summarised that enhancing knowledge, awareness, confidence, involvement, and commitment of employees towards the lean implementation practices through training and learning programs, top management involvement, and governmental policies will contribute in overcoming the human related challenges in lean implementation in construction industry. On the other hand, Bashir et al. (2015)

and Belhadi et al. (2016) suggested that avoiding the sudden cultural changes within an organisation due to the lean implementation practices is healthier for smooth continuation of implementation. Further, the authors emphasized the importance of gradually teach the fundamentals of concept and implement through different stages over a considerable period of time, so that the employees will be able to seize the chance to understand and apply lean tools efficiently and effectively.

2.10 Lean enabling human capacities

Understanding lean and organisational capacities has become a vital necessity for creating customer values through successful lean implementation (Linne & Ekhall, 2013). Although many organisations have implemented lean concept, yet some organisations have failed to achieve the anticipated goals of lean implementation due to several factors (Staats et al., 2011). Hence, the past researchers have identified a series of factors, which could be critical in the successful lean implementation (Emiliani, 2006; Bateman, 2005; Olivella et al., 2008).

According to Martínez-Jurado et al. (2014), human capacities and the cultural establishment, which sustain the successful lean implementation are some of the critical factors as mentioned above. Further, several research lines in the previous literature have emphasized the links between lean implementation and human resources management, capacities, and policies, which provides evidence on the possibility of fostering lean concept through human capacity building (Olivella et al., 2008; Biazzo & Panizzolo, 2000; Niepce & Molleman, 1996). Continuous improvement of organisations to new levels is one of the major aspects of lean concept and people's knowledge and intelligence is directly driving the continuous improvement process (Bhasin, 2012). Teamworking, ongoing training, versatility and participation are some of the human capacity building methods, that have a good fit with lean concept (Pil & MacDuffie, 1996). Further, training individuals in the organisational level has been identified as another approach for improving the lean capacities within the organisations (Kululanga, 2012; Lopes & Theisohn, 2003). The identification of human capacities, which enables the LC implementation is essential to investigate as shown in the below section.

2.11 Human capacities necessary for lean implementation in construction industry

Both academics and practitioners have recently paid the attention towards the human and cultural factors that hinder the successful lean construction implementation (Pavez & Alarcón, 2006). According to Koskela et al. (2014), LC requires changes in individual behaviour and thus, building individual capacities will accelerate the lean

implementation. Further, some researchers identified that skills and capacities of human and how they respond to changes as major challenges that construction organisations are heavily facing in the perspective of LC implementation (Sawhney & Chason, 2005). Green et al. (2008) highlighted that transformation towards LC from lean production will lead to changes in human resources and their culture, which are paramount for successful lean implementation. As a result, the requirement of human capacities for successful LC implementation has been clearly emphasised. Hence, the human capacities to be developed by human resources in different hierarchical levels including top level management, middle level management, operative level management, administrative and operative level employees and, skilled and unskilled level workers for successful implementation of lean concept in construction industry are summarised in Table 2.10. Top part of the table summarises common capacities for two or more hierarchical levels in an organisation and the later part of the table presents capacities unique to each hierarchical level.

Table 2.10: Human capacities necessary for lean implementation in different hierarchical levels

Top Level Management		Middle Level Management		Operative Level Management		Administrative & Operative Level Employees		Skilled & Unskilled Level Workers	
Human Capacities	Ref.	Human Capacities	Ref.	Human Capacities	Ref.	Human Capacities	Ref.	Human Capacities	Ref.
Common Capacities for Two or More Hierarchical Levels									
True understanding	(1)	True understanding	(1)	True understanding	(1)				
Decision making	(1)	Decision making in the project level	(7)						
Standard and systematic way of work	(1)	Standard and systematic way of work	(1)						
Effective work allocation	(2)	Effective work allocation	(2)	Effective work allocation	(2)				
Collaborative management	(3)	Collaborative management	(3)	Collaborative management	(3)				
Commitment	(4)	Commitment	(12)	Commitment	(12)				
Education level	(5)	Education level	(5)	Education level	(5)				
Ability of understanding new concepts	(2)	Ability of understanding new concepts	(2)	Ability of understanding new concepts	(2)			Ability of understanding new concepts	(2)
Continual professional development	(6)	Continual professional development	(6)	Continual professional development	(6)				
Training	(7)	Training	(7)	Training	(7)			Training	(7)
Learning	(8)	Learning	(8)	Learning	(8)			Learning	(8)
Sharing knowledge on lean construction	(9)	Sharing knowledge on lean construction	(9)	Sharing knowledge on lean construction	(9)				
Patience	(10)	Patience	(10)	Patience	(10)			Patience	(19)
Consistency	(10)	Consistency	(10)	Consistency	(10)				
Personal Interest	(10)	Personal Interest	(10)	Personal Interest	(10)				

Top Level Management		Middle Level Management		Operative Level Management		Administrative & Operative Level Employees		Skilled & Unskilled Level Workers	
Human Capacities	Ref.	Human Capacities	Ref.	Human Capacities	Ref.	Human Capacities	Ref.	Human Capacities	Ref.
Effective planning	(3)	Effective planning for sub units	(13)	Executing plans implemented by middle levels	(16)	Executing plans implemented by middle levels	(16)		
Communication skills	(11)	Communication skills	(11)	Communication skills	(14)	Communication skills	(14)	Communication skills	(16)
Passion and tenacity about lean	(1)	Passion and tenacity about lean	(1)						
		Knowledge to implement plans	(13)	Knowledge on lean practices, tools	(17)	Knowledge on lean practices, tools	(17)	Knowledge on lean practices, tools	(17)
Capacities Unique to Each Hierarchical Level									
Respect	(8)	Interpreting lean practices to lower - level management	(14)	Maintaining communication circles	(3)	Networking/ internal relationship building	(8)	Flexibility	(14)
Challenge	(8)	Inspiring lower-level management	(15)	Supervisory skills	(18)	Ability of supervising among colleagues	(18)	Creativity	(14)
Quality of work life	(2)	Acknowledging and rewarding co-workers	(3)	Upholding discipline	(14)	Ability to get along with others	(8)	Ability to get along with others	(8)
Problem solving ability	(9)	Contribution in effort improvement	(7)	Upholding harmony	(14)	Ability to document and reporting results	(8)	Sense of humour	(14)
Long term thinking	(8)					Capacity to change to new procedures	(7)	Team building	(19)
Effective coordination	(3)					Ability to synthesize information	(7)	Enthusiasm and energy	(18)
References: [1] Nesensohn et al., 2014; [2] Alsehaimi & Koskela. 2008; [3] Mossman, 2005; [4] Alves et al., 2016; [5] Karami et al., 2006; [6] Basil, 2005; [7] Aziz & Hafez (2013); [8] Construction Industry Institute (CII), 2007; [9] Koskela, 1992; [10] Parfenoval et al., 2020; [11] Gabriel, 1997; [12] Ankomah et al., 2017; [13] Groot & Molen, 2001; [14] Pavez & Alarcon, 2006; [15] Bhasin, 2012; [16] Jin & Ling, 2005; [17] Rymaszewska, 2014; [18] Enermak & Ahene, 2002; [19] Tezel et al., 2017									

The human capacities, which are common for two or more hierarchical levels of human resources have been mapped initially in Table 2.10. Further, the human capacities unique to each hierarchical levels have been mapped under the heading of “Capacities Unique to Each Hierarchical Level” and have been highlighted with different colours in the Table 2.10.

When considering the managerial level staff, Table 2.10 evidenced that managerial level staff are the starting point and the ongoing foundation of the successful lean construction implementation. Accordingly, the human resources from each management levels are essential to have the knowledge on lean concept to different extents along with the managerial skills including planning, organising and coordination skills to execute the developed lean strategic procedures (Groot & Molen, 2001). Further, managerial staff must have the ability of interpreting and inspiring the lower-level management to successfully implement lean concept in construction industry. According to Table 2.10, several human capacities are essential to be developed within the top-level management rather the middle and operative level management staff. The ability of developing interpersonal relationships with the human resources from each hierarchical level and getting along with the other co-workers have been highlighted as important human capacities to be developed within the administrative and operative level employees. Moreover, the necessity of synthesise information systems and capacity to change with the new culture adopted within the organisation can be identified as human capacities necessary to be built within administrative and operative level employees. Skilled and unskilled level workers are the human resources in the bottom of the hierarchical levels of construction organisation whom are necessary to be actively involving in the implementation procedure of the several strategic plans executing by top management levels. Thereby, the necessity of ensuring the flexibility, creativity, patience, team building, and enthusiasm have been highlighted in the previous researches as emphasised in Table 2.10. When considering the SMC in Sri Lankan context, the human capacities necessary for successful lean construction implementation have been identified under seven categories namely knowledge, critical thinking, positive attitudes, communication, team building, work ethics and leadership skills (Ranadewa et al., 2021). The authors have further emphasized the importance and significance impact of building the human capacities under the aforementioned sub categories for the success of lean construction implementation in Sri Lankan context. Hence, the human capacities and building human capacities can be presumed as an important consideration in the successful implementation of lean concept in construction industry.

2.12 Strategies for building human capacities to foster lean construction

Human capacity building strategies in construction industry can be identified at different levels including the contributions made by individual, organisational, industrial and governmental levels (Kululanga, 2012). Hence, the strategic actions to be taken for building lean enabling human capacities can be explained under the aforementioned individual, organisational, industrial and governmental levels.

2.12.1 Individual level strategies for building human capacities to foster lean construction

Belout (1998) highlighted that individual employee must be committed to lifelong learning in lean environments. According to Love et al. (2001), the individuals must have the continuous desire on learning through the opportunities available within the organisations and industry. The individual employees can enhance their lean knowledge by attending training programmes (Belhadi et al., 2016). Further, Love et al. (2001) highlighted the importance of the individual commitment to attend training programmes conducted within the organisation and in the industry. Along with building the individual commitment, the importance of growing the self-confidence and high commitment of individuals have also been highlighted as a strategy towards fostering lean construction by Green and May (2005). Further, some researchers have emphasized that the awareness and the committed involvement of the individual employees throughout the lean implementation process as significant strategies to build lean enabling human capacities (Bakas et al., 2011; Belhadi et al., 2016). Among the strategies, improving the morale of employees by themselves have been stressed by some researchers such as Howell et al. (2017) and Leite et al. (2013). According to Green and May (2005), the self-development of “soft skills” by employees of an organisation is a significant strategy of eliminating several human related issues. According to the authors, the individuals need to be self-committed to improve the soft skills by attending the in-house or external training programs on corporate etiquette.

Hence, the individual level strategies for building human capacities to foster lean construction can be summarised as:

- Continues urge on learning lean concepts (lean learning)
- Individual commitment on training lean practices
- Develop self-confidence and commitment
- Enhance the individual knowledge through self-learning process
- Enhance the self-awareness of lean practices throughout processes
- Improving individual morale by themselves

- Self-development of soft skills

2.12.2 Organisational level strategies for building human capacities to foster lean construction

The strategies that can be practiced in an organisation level to build human capacities for implementing LC can be considerably challenging due to lack of coordination among relevant initiatives, lack of organisational capacity and the conventional ways of project delivery (Kululanga, 2012). Further, the author has emphasized that organisational level initiatives towards the human capacity building is depending on the size and the nature of the construction organisations. Accordingly, several strategies than can be employed in building lean enabling human capacities at organisational level have been highlighted by various authors.

According to Bossink (2004), human capacities can be developed by organisations through several strategies such as, promoting training and learning within organisation, encouraging mentoring and making the individuals realise on the big picture of benefits of the lean implementation. Correspondingly, Alves et al. (2016) stated that many companies are developing their own lean education programmes to train the employees. Adopting and maintaining a supportive lean culture within the organisation is another strategic option, which can be established by the organisation (Bortolotti et al., 2015). According to Kull et al. (2014), adopting a lean culture within organisation would enhance the commitment of employees and involve the employees in improving organisation. Taking necessary actions to enhance the effective collaboration among individuals to increase trust, teamwork and cooperation is another significant strategy in organisational level proposed by Green and May (2005). This can be highlighted in the term of persuading individuals to work with others in team and partnership (Disterer, 2002).

Organisations can extend the experiments in the aspects of new developments in organisations through research and development practices. The aforementioned initiative can be supported by sharing new working procedures, tools and technologies with the external organisations, while uplifting the own organisational capacities to achieve the future circumstances (Jin & Ling, 2005). Moreover, Green and May (2005) emphasised more instrumental strategy of focusing on better planning and organising of individual tasks within an organisation. According to the authors, the aforementioned strategy would lead the organisations to build the human capacities in a more specific way. Dave (2013) and Sim and Chiang (2012) highlighted the importance of having rewards scheme to motivate the individuals who perform well in lean implementation.

Hence, the organisational level strategies for building human capacities to foster lean construction can be summarised as;

- Support individuals to obtain required lean knowledge
- Promote training and learning within organisation
- Encourage mentoring and enhance individual awareness on lean benefits
- Adopt lean culture within the organisation
- Persuade individuals in partnerships to work with others
- Promote new developments within an organisation
- Improve the organisational capacities to respond to present and future
- Plan and organise individual tasks effectively within the organisation
- Have a rewards scheme to motivate the lean implementors

2.12.3 Industry level strategies for building human capacities to foster lean construction

At the construction industry level, collaboration among several industry players such as public and private construction organisations, Construction Industry Development Authority (CIDA), non-governmental organisations and professional institutions can be identified in Sri Lankan context (Ranadewa et al., 2019). In order to support the human capacity building to foster LC, inter and intra industry level relationships have been suggested by researchers (Bossink, 2004). Alves, Milberg and Walsh (2012) identified the necessity of the collaboration of industry and academics practitioners in the adaptation of lean concept and systems. The three dominant models that have been developed by Green and May (2005) with respect to the lean construction adaptation within the construction industry can be provided as an example for the aforementioned fact. Waste elimination was the main focus of the model 1 while model 2 highlights on partnering and model 3 is on structuring the context. Among the aforementioned three models, the third model can be represented as a true rethink of traditional models, which is being sensitive to the individuals and suggestive to the adaptation of lean in construction industry. Accordingly, Green and May (2005) suggested that construction industry must build the innovative models for individuals and organisations in the sense of lean construction implementation. Development of new collaborative procurement forms (Cicmil & Marshall, 2005), partnering forms (Bresnen & Marshall, 2000) and integrated project delivery forms (Bygballe et al., 2015) are evident as significant strategies to build human capacities through collaboration and teamwork and hence enhance the lean implementation in construction industry.

Further, seminars and workshops can be conducted by the construction industry organisations and academic institutions to enhance the lean awareness of individuals in the construction setting (Bygballe et al., 2018). According to Bygballe et al. (2018),

newly developed procurement strategies by industry practitioners in Norway ensure that the contractors possessed a sufficient level of lean competence, appropriate human resources and necessary commitment to comply with the project requirements. This strategy has the potential to enrich the human resources with human capacities and leads towards fostering the lean concept in construction industry.

The collaboration with public research development bodies is highlighted as a significant approach for building human capacities due to the production of new sources and methods of knowledge and skills in the construction industry (Kulatunga et al., 2007). The publication of research works by construction industry authorities and academic institutions, which are conducted on lean construction have been identified as another strategy since those publications will allow the individuals to be aware on the new approaches and solutions offered for lean constructions (Ranadewa et al., 2019). Further, the authors highlighted that this strategy can be achieved through conducting research conferences by construction industry authorities.

In response to the company needs of different organisations, Harris et al. (2014) highlighted the importance of lean education programme or significant curricula for workforce development. Though some companies are developing their own training programmes (Alves et al., 2016), many organisations do not have the budget or infrastructure requirements to provide these facilities (Flumerfelt et al., 2017). Hence, Flumerfelt et al. (2017) highlighted the importance of providing the lean education and training programmes by external lean institutes or higher education institutes to shape the lean thinking in professionals. Some of the developed countries such as USA, UK, and Singapore have established the lean institutes in industry level to provide consultation and training to professionals through lean trainers (Abdullah et al, 2009). Accordingly, produce lean trainers by lean institutes is a significant strategy to be implemented in industry level.

Hence, the industry level strategies for building human capacities to foster lean construction can be summarised as;

- Enhance collaborative practices among parties in the construction industry
- Encourage academic industry partnerships in lean research
- Build the innovative models for individuals and organisations
- Develop new collaborative procurement forms, partnering forms and integrated project delivery forms
- Conduct seminars and workshops on lean construction
- Publish research on lean construction by construction industry authorities and institutions
- Organise lean conference by relevant authorities and institutions
- Produce lean trainers by lean institute

2.12.4 Government level strategies for building human capacities to foster lean construction

The contributions of governmental level towards the human capacity building to foster the LC have been identified in several aspects. According to Kululanga (2012), the government bodies can influence the construction practices through the laws and regulations, which will have the possibility of enhancing the capacity building of humans. Providing loans at concessional interest rates for SMCs who try to implement lean by the government have been identified as an example for the aforementioned strategy by Ranadewa et al. (2019). Moreover, government can take actions in providing incentives for the lean implemented organisations such as introducing tax exemptions and reward mechanisms (Sarhan & Fox, 2013). This strategy will increase the likelihood of leaner practices among individuals and the morale of human resources to implement lean practices within organisations (Demirkesen & Bayhan, 2019).

Irrespective of that, the stable economic and political environment with the effective policies, rules and regulations have the considerable contribution towards the human capacity building (Al-Sedairy, 2001). Correspondingly, the organisations will be forced to rethink the ways and means of shaping the operations and process, to be compiled with the government policies by incorporating lean practices (Garza-Reyes, 2015). More broadly, the individuals will be capable of overcoming the inadequacies and meet the required educational levels and qualifications due to the flexible environment developed through the sound governmental policies (Al-Sedairy, 2001).

Hence, the governmental level strategies for building human capacities to foster lean construction can be summarised as;

- Introduce new laws and regulations to support lean implementation
- Provide loan facilities at concessional interest rates for the construction projects intending to implement lean concept
- Provide tax concessions for lean implemented projects
- Establish stable economic and political environment within the country

2.13 Advantages in building human capacities necessary for fostering lean in construction industry

Among the several critical success factors, which might be influencing the successful implementation of lean construction, commitment of management and involvement, knowledge requirement by training and education, enhance the involvement and properly applying lean tools and techniques have been identified (Achanga et al.,

2006). The aforementioned factors are providing clear evidence that building human capacities are driving the lean construction implementation towards a huge success. Meanwhile, the advantages that can be achieved through building human capacities in lean construction implementation both in individual and organisational levels have been highlighted by the researchers worldwide. Building human capacities such as creativity, and new thinking are encouraging the top management level staff to explore and innovate in the use of human resources to provide new thinking to the organisation, while addressing the flexible market responses through emerging new thinking to the organisations (Davies & Brady , 2000). Further, Bartlett and Ghosal (2002) have highlighted the top management's ability to capture the maximum possible economic value and creating value within the organisation through their human capacity building. With the developed and strengthen employee performances, trust and commitment of managerial staff of an organisation, the ability of achieving higher profitability to the organisation while increasing the long-term benefits to themselves have been highlighted as another advantage (Gul et al., 2012). When considering the middle management level, Hartline and Bejou (2012) have highlighted the ability of building atmosphere of coordination and peace among lower-level management and improving communication lines between management levels. Further, the ability of increasing the trust and commitment of middle management staff has also been highlighted in the literature findings (Leonard, 1995). Increasing the trust and commitment level of operative level management have also been highlighted by Leonard (1995). Further, Teixeira and Werther (2013) have highlighted that building human capacities would enhance the confidence level of operative level management staff regarding the future growth and success of the organisation through the lean practices.

The ability of giving a training for the exact skills that an organisation requires in lean implementation for the administrative and operative level employees have been highlighted by Hartline and Bejou (2012) as another advantage of human capacity building in lean implementation. Further, the authors have emphasised the importance of the possibility of developing proper relationship among the human resources of different hierarchical levels. According to Hagel et al. (2020), building human capacities would be advantageous for skilled and unskilled workers in the context of continuously adopting and acquiring needed skills for lean implementation, and better accessing talent and increasing motivation towards lean implementation. Moreover, developing human capacities would create a win-win environment for workers, which would allow the workers to perform with better productivity to enhance the performances (Hagel et al., 2020). Further the authors have emphasised that, skilled and unskilled labours would be able to move away from routine performances and able to learn from new approaches established within the working environment.

2.14 Conceptual model

A conceptual model is the researcher's description of how the research problem will be investigated (Liehr & Smith, 1999). A conceptual model is linked with the concepts, empirical research and important theories used in the study by researcher and arranged in a logical structure to provide a visual display of how ideas are interrelated (Grant & Osanloo, 2014). According to the authors, it is important to build a conceptual model in a particular study since it will assist the researcher to identify and construct the phenomenon to be investigated.

This study aims to develop a model to foster LC through human capacity building in Sri Lankan construction industry. As per the literature findings, the determinants of capacity building can be identified at individual, organisational, industrial and governmental levels. Moreover, the strategies to build human capacities in each aforementioned level to foster lean construction were reviewed in this chapter. Further, the human resources in construction industry were identified under Top-Level Management, Middle Level Management, Operative Level Management, Administrative and Operative Level Employees, and Skilled and Unskilled Level Workers and also human capacities necessary to foster lean construction have been identified. A conceptual model developed to elaborate the human capacities and strategies to build human capacities necessary to lean implementation in construction industry is presented in Figure 2.1.

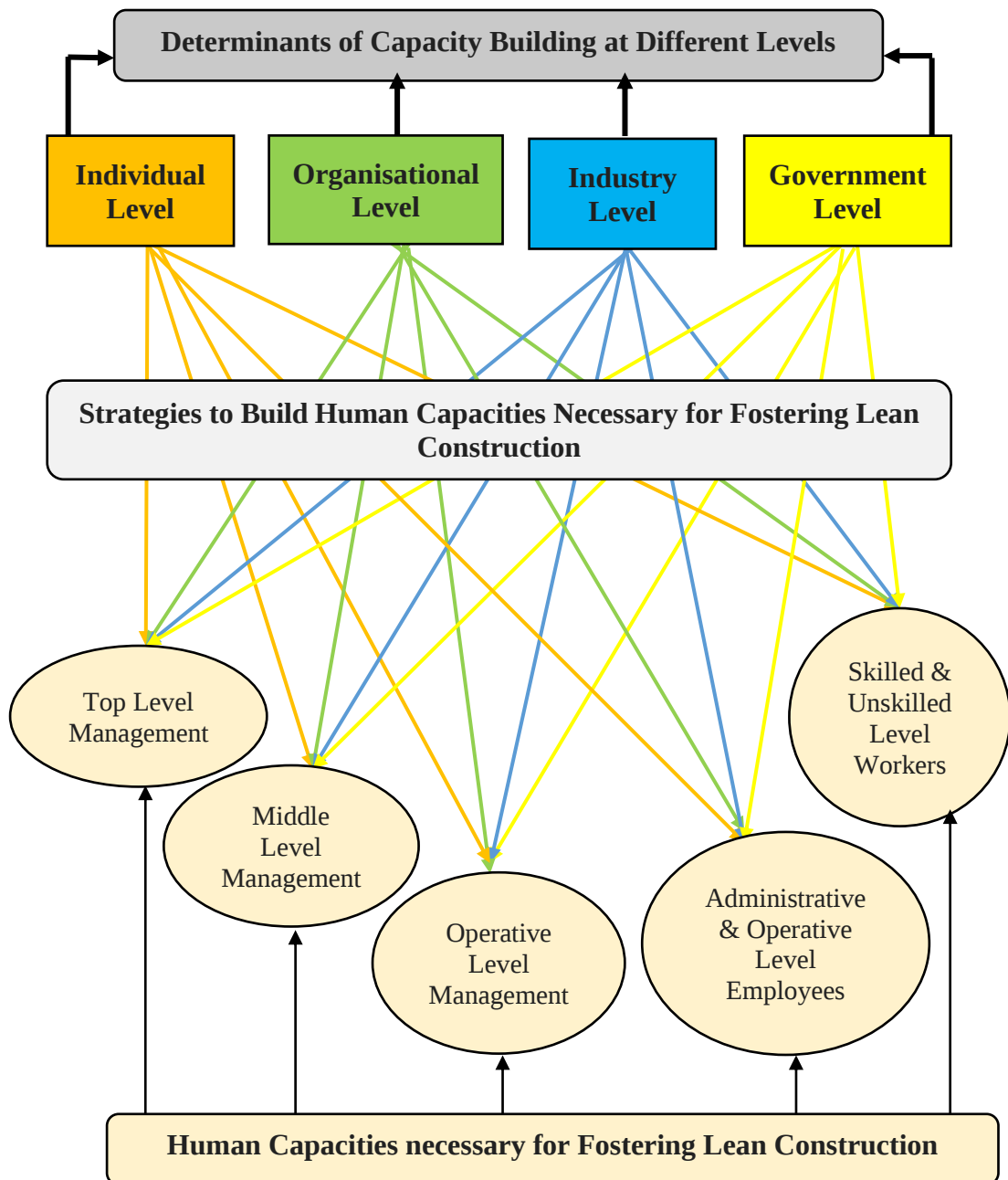


Figure 2.1: Conceptual Model

This conceptual model was used for the empirical study, in order to identify human capacities necessary to foster lean construction and to propose strategies to successfully build identified human capacities in Sri Lankan construction industry.

2.15 Chapter summary

The in-depth literature review strengthened the background on how to foster LC through the human capacity building in construction industry. Definitions of LC and

human capacity building were provided in this chapter with the intention of providing a clear understanding on the lean concept and human capacity building, respectively. The literature review gave a clear and broader picture of the fundamentals of lean concept, introduction to LC, and drivers, challenges and strategies to overcome those challenges in LC implementation. Further, the synthesised literature provides an outline to the introduction of human capacity building, human related challenges in LC implementation and strategies to overcome those challenges. Subsequently, the literature review outlined the human capacities, which are necessary to foster LC in construction industry. Finally, the strategies that have been identified to build the human capacities that are necessary to foster LC have been provided in the literature synthesis, evidencing the ways of fostering LC through human capacity building.

3 RESEARCH METHODOLOGY

3.1 Introduction

Research can be defined as a process conducted by people in order to discover things in a systematic manner, hence increasing knowledge levels (Saunders et al., 2009). Research is based on logical relationships, which are not just beliefs of people (Ghauri & Gronhaug, 2005). The theory on how research should be conducted, which provides overall guidelines to address the research problem, is referred to as research methodology (Dawson, 2007). The research journey, which has been used to accomplish the aim and objectives are outlined in this chapter including research design, approach and research process.

3.2 Research philosophy

In constructing a philosophical viewpoint for a study, the researchers consider numerous key assumptions on two dimensions namely nature of society and nature of a science (Burrell & Morgan, 1979). Sexton (2003) has graphically positioned the taxonomies that lay in extreme philosophical positions and in between. The axiology of the research is determined by the ontological and the epistemological positioning of the researcher.

Ontology is referred to the nature of reality, that questioned regarding the assumptions of researchers regarding how the world operates, and the commitment held to particular views (Saunders et al., 2009). There are two particular ends of ontology as realism and idealism. The realism has been explained by Amaratunga et al. (2002) as being born into a social environment which exists, its own reality. In idealism, reality can be varied from place to place over a time span since the reality initiates with the ideas, thoughts or perceptions of people. In this study, the human related challenges of building human capacities and human capacities necessary in lean construction implementation are directly associated with human interactions. Further, for proposing strategies to build human capacities necessary to foster lean construction and mechanisms to overcome the difficulties in implementing those strategies, the realism would not be suitable. Thereby, this study was skewed to the ontological assumption of idealism, which is socially constructed since the study valued the human interactions.

Epistemology is concerned with the assumptions on the valid knowledge and the methods of communicating the knowledge to the others (Burrell & Morgan, 1979). There are two extremes in epistemology as well. According to Saunders et al. (2009), the one extreme suggest that knowledge is observable and evidences based with the objectivity whereas the other extreme relies upon the knowledge and opinions of people based with the subjectivity. Thereby, since the study is considering the opinions

of experts in building up the knowledge regarding the human related challenges, human capacities, advantages of building human capacities and strategies to build human capacities necessary to foster lean construction, subjectivity was highlighted in the epistemological stance.

In the Axiology, a set of values and ethics are referred throughout the research process that would questioning about the way of researchers and its participants are dealing with their own values and ethics (Saunders et al., 2019). Value laden and value free are the two extremes of axiological assumption. Considering the axiology, the study took the value bound stance considering that researchers are part of what is researched. Further, Saunders et al. (2009) argued that interpretivist perspective would be highly appropriate particularly in field such as human resource management. Hence, this research study was in line with the interpretivism stance, which the researcher has to adopt an empathetic stance.

3.3 Research process

Research process is constituting with the multiple steps and decisions made by the researcher in a research journey to reach the specified aim and objectives (Mackenzi & Knipe, 2006). According to Saunders et al. (2009), the key steps in a research process can be identified as framing research problem, defining aim and objectives, reviewing literature, establishing research approach, strategy, collection of data and analysis mechanisms as illustrated in Figure 3.2.

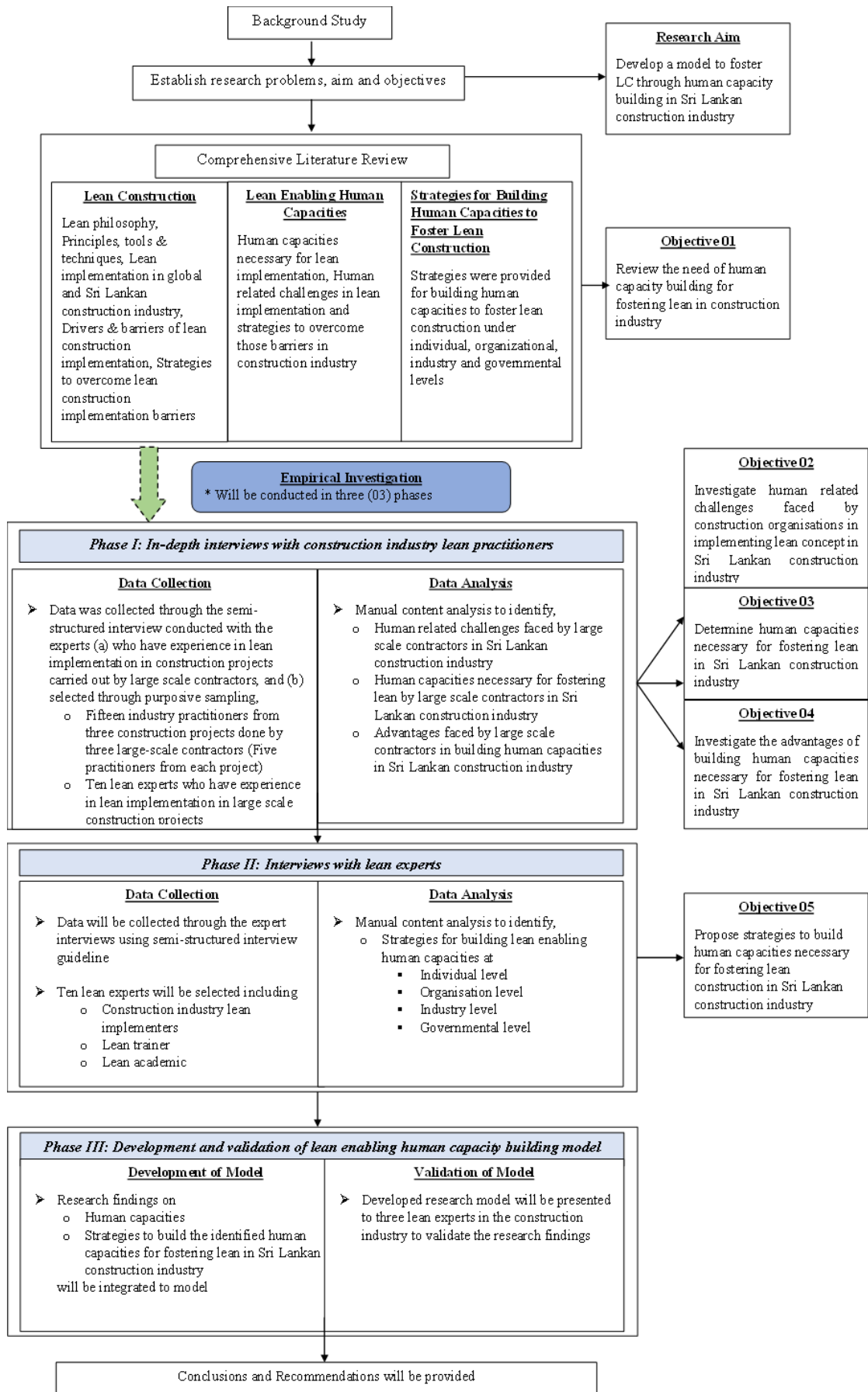


Figure 3.1: Summary of research process

3.3.1 Background study

Background study was carried out in chapter one, which lead the researcher to identify the current gap in research area. During the background study, literature on lean construction and lean enabling human capacities were reviewed. Further, it was identified that there is a lack of evidence on the empirical investigation on lean enabling human capacities and strategies to build human capacities necessary for enabling lean in construction industry at large scale contractors. Therefore, the research aim was set to develop a model on how to foster LC through human capacity building by large-scale contractors in construction industry.

3.3.2 Literature review

An in-depth literature synthesis was carried in align with the aim and objectives established in chapter one. Literature review was conducted on the need of human capacity building and strategies for building human capacities for fostering lean in construction industry, which allowed the researcher to achieve Objective 1 of the study. Several literature sources such as journals, conference proceedings, reports, books, and official websites were reviewed by the researchers in this in-depth literature synthesis. This review provided a base to proceed with the study. The key findings extracted from the literature survey had been inbuilt to a conceptual model, which was used as a guide in empirical investigation.

3.3.3 Research approach

Research approach can be categorised under two distinctive types namely qualitative and quantitative approaches (Amaratunga et al., 2002). According to the authors, each approaches have different strengths and weaknesses and therefore, mixed approach would be the best approach to deal with the weaknesses of each method. In order to choose the most suitable approach to a particular research study, the investigation on each approach is necessary.

The quantitative approach generally follows a rigid procedure to determine the extent of a phenomenon based on a large sample size and communicating them in an analytical and aggregate manner (Kumar, 2019). According to Amaratunga et al. (2002), quantitative research determines the truth value of propositions and allows a flexibility of data through comparative and statistical analysis. However, quantitative approach would not be suitable to be adopted in a research study when the required amount of data sources is not available.

The qualitative research is generally linked with some specific data such as words or images other than numerical. Further, the author has described qualitative research as a naturalistic and interpretative approach, which taking the perspectives and accounts of research participants. According to Ormston et al. (2003), semi structured and in-depth interviews, observational methods, and focus groups have been identified as data

collection techniques related to the qualitative approach. Moreover, the authors have pointed out that qualitative approach is concerning with “what”, “why” and “how” rather than “how many”. The qualitative approach is much suitable to be undertaken for, which the small numbers of respondents are existing (Yin, 2011).

Mixed method approach incorporates both qualitative and quantitative research approaches (Amaratunga et al., 2002). According to the authors, the mixed method approach has the more potential to provide insight on the results of the study and contribute in making inferences and draw more reliable conclusions. Abowitz and Toole (2009) emphasised that mixed method approach has the ability to ensure the reliability and validity of research output.

The aim of the study is to develop a model to foster LC through human capacity building by large-scale contractors in construction industry. In order to pursue the research aim, a vigorous analysis of lean concept is necessary in terms of human capacities necessary to foster lean construction, advantages of building human capacities and strategies to build the human capacities necessary in lean construction implementation. In order to achieve the above, opinions and knowledge of experts are mandatory, which established the requirement of in-depth investigation. Moreover, the lean concept has been evolving since the early 1970s. According to Yin (2011), qualitative approach enables to explore more on emerging concepts through an in-depth investigation. Further, the lack of applicability of the lean concept in the construction industry of Sri Lanka limited the collection of a large sample of respondents to the data collection. Thereby, considering the aforementioned factors, this research study has taken a qualitative approach.

3.3.4 Research strategy

As per the Saunders et al. (2018), experiment, survey, case study, action research, grounded theory, ethnography and archival research were identified as main research strategies. Among the aforementioned strategies, the survey research strategy was adopted for the study. According to Check and Schutt (2012), survey can be identified as the information collection from a sample on individuals through the responses to a particular set of questions. More significantly, survey strategy allows a researcher to adopt several data collection techniques including quantitative technique through questionnaires, and qualitative technique with in-depth interviews and focus group discussions (Singleton & Straits, 2009). Further, Ponto (2015) suggested that survey strategy is ideal for exploratory behaviours and preferences in a more rigorous manner using multiple valid and reliable instruments. Therefore, this study adopted a survey strategy with qualitative data collection technique in order to focus on the human capacities necessary to foster lean construction in the large- scale contractors of Sri Lankan construction industry.

3.3.5 Data collection

The choice of data collection technique depends on the reliability, appropriateness, and volume of data intending to be collected in the study (Harrell & Bradley, 2009). According to Saunders et al. (2009), the survey strategy allows a researcher to collect quantitative data, which can be analysed using descriptive and inferential statistics. However, the authors have further emphasized that questionnaire is not the only data collection technique that belongs to the survey strategy as mentioned before. Therefore, Saunders et al. (2009) emphasized that interviews, where standardised questions are asking of all the interviewees also often belong to this strategy. Generally, there are three types of interviews, which are conducting with the use of different interview guidelines named as structured, unstructured and semi-structured guidelines (Srivastava & Thomson, 2009). Among the aforementioned methods, semi-structured interviews were emphasised as partially informal discussion between parties where the interviewees are allowed to answer the set of pre-determined and open-ended questions (Srivastava & Thomson, 2009). Thereby, this study adopted the expert interviews, which are conducting with the use of semi-structured data collection instruments. The empirical investigation of the study was conducted in three phases as described below.

Phase I: In-depth interviews with construction industry lean practitioners

In the first phase of in-depth interviews, data was collected through the semi-structured interviews conducted with the experts who have have experience in lean implementation in construction projects carried out by large scale contractors, and selected through purposive sampling. Accordingly, interviews were conducted with 25 subject matter experts comprised of:

- 15 industry practitioners who have experience in three ongoing large-scale construction projects and
- 10 construction industry lean implementers, lean trainers and lean academics.

The in-depth interviews were undertaken to investigate human related challenges faced by construction organisations, and human capacities necessary to foster lean in Sri Lankan construction industry (Objectives 2 and 3). Further, the advantages in building human capacities were investigated during this phase to achieve Objective 4.

Phase II: Interviews with lean experts

Having identified the challenges faced by construction organisations, human capacities necessary for fostering lean and advantages in building human capacities in Phase I, Phase II was focused on the identification of strategies to be used for building human capacities to foster lean in Sri Lankan construction industry. Ten construction industry lean implementers, lean trainers and lean academics who were selected in

phase I were again interviewed using semi-structured interview guideline to identify the strategies for building lean enabling human capacities to achieve Objective 5. The collected data was analysed through manual content analysis.

Phase III: Development and validation of lean enabling human capacity building model

During Phase III, the research findings on the human capacities and strategies to build the identified human capacities for fostering lean in Sri Lankan construction industry was integrated in to a model. Finally, the developed human capacity building model to foster lean construction was presented to three lean experts who were selected among the ten experts interviewed in Phases I and II to validate the research findings and hence, to achieve the aim. The researcher was actively seeking the alternative explanations from the selected experts to the findings in order to strengthen the validity of the research findings.

3.3.6 Data analysis

Qualitative data analysing technique was used as the data analysing technique since the research study administered a qualitative approach. Content analysis is an ideal method to analyse a set of certain words, themes, or concepts within some given qualitative data (Hsieh & Shannon, 2005). The authors highlighted that content analysis has the possibility of identify the intentions, focus or communication trends of an individual, or group of people. Hence, the content analysis has been adopted in this study. The coding of texts can be done either using a software or manually. Accordingly, in this study, the manual content analysis has been used as data analysis technique. Further, the analysed data in Phase II have been integrated in to separate cognitive maps as a summary. Accordingly, the summarised data on human related challenges, necessary human capacities, and strategies to build the identified human capacities have been illustrated in separate cognitive maps.

3.3.7 Chapter summary

The followed research journey to achieve the aim and objectives of this study were described in this chapter. Brief explanation to the research design, research philosophy, research approach, research strategy and research process, which were undertaken in this study were emphasised in this chapter. The research was adopted qualitative research approach and survey research strategy. The main stages of this research study were background study, in-depth literature review, and empirical investigation, which was carried out in three phases using semi structured interview as data collection technique, and data analysis.

4 RESEARCH FINDINGS AND ANALYSIS

4.1 Introduction

This chapter presents the analysis of collected data and research findings. The findings assist to develop a model to foster Lean Construction (LC) through human capacity building by large-scale contractors in construction industry. Data collection for the study was conducted in three phases using semi-structured interview guideline with the experts who have experience in lean implementation in construction projects carried out by large scale contractors, and other subject matter experts selected through purposive sampling. The data analysis and research findings of Phases I, II, and III are elaborated in this chapter.

4.2 Phase I – Data Collection, Analysis and Findings

The data collection technique adopted in Phase I was in-depth interviews. Accordingly, in Phase I, the in-depth interviews were conducted with 25 subject matter experts comprised with 15 industry practitioners who have experience in 03 ongoing large-scale construction projects and 10 construction industry lean implementers, lean trainers and lean academics. The experts representing both large-scale ongoing construction projects and large-scale construction organisations were selected with the intention of bringing their knowledge on how the lean philosophy has been implemented within each entity. The 10 lean experts, who have experience in lean implementation in large scale construction contractors were selected to obtain the domain specific knowledge enriched with both the theoretical knowledge and practical experience in the area of lean construction. Moreover, since the study has investigated several aspects of lean implementation with respect to the different human resources of different hierarchical levels, the authors realised the need of obtaining the expert opinions who are practically engaging with standard work procedures at each human resource level within a working environment. Therefore, 15 experts from senior management level of three ongoing construction projects done by large scale contractors were selected in order to bring their practical knowledge, experience, and standardised working procedure adhered within the lean implemented working environment.

In this phase, the experts were questioned regarding the human related challenges faced in lean implementation, human capacities necessary to lean implementation, and advantages of building human capacities necessary to successful lean implementation in Sri Lankan construction industry using the interview guideline given in Appendix

D. The profiles of the respondents from selected construction projects and experts in research area are elaborated in Table 4.1.

Table 4.1: Profiles of respondents of in-depth interviews

Code	Designation	Years of experience	Role within the organisation
R1	Project Manager	Total 34 years in construction industry. Over 30 years up to date at Project A organisation.	Overall responsible person for construction at Project A organisation while providing leadership to the director board to carry out works effectively and efficiently
R2	Deputy Project Manager	Total 20 years in construction industry. Over 10 years up to date at Project A organisation.	Overall responsible person for construction at Project A organisation. Providing leadership to carry out construction at Project A
R3	Planning Engineer	Total 23 years in construction industry. Over 15 years up to date at Project A organisation.	Responsible for the planning works of construction Project A and providing leadership to lean implementation within project
R4	Site Engineer	Total 15 years in construction industry. All the 15 years at Project A organisation.	Responsible for managing of crew members, completing quality assurance of project A
R5	Quantity Surveyor	Total 12 years in construction industry. Over 5 years up to date at Project A organisation.	Responsible for managing the contractual and financial side of the construction project A.
R6	Project Manager	Total 35 years in construction industry. Over 20 years up to date at Project B organisation.	Overall responsible person for construction at Project A organisation.
R7	Construction Manager	Total 30 years in construction industry. Over 15 years up to date at Project B organisation.	Responsible for the practical management and planning of every stage of a construction at Project B.
R8	Resident Engineer	Total 16 years in construction industry. Over 10 years up to date at Project B organisation.	Responsible for ensuring the quality, time and cost requirement of the construction at Project B
R9	Site Engineer	Total 11 years in construction industry. Over 6 years up to date at Project B organisation.	Responsible for managing the skilled and unskilled labours of the construction Project B
R10	Quantity Surveyor	Total 13 years in construction industry. Over 10 years up to date at Project B organisation.	Responsible for managing the contractual and financial side of the construction project B.
R11	Project Manager	Total 33 years in construction industry. Over 22 years up to date at Project C organisation.	Overall responsible person for construction at Project C while providing leadership in lean implementation within construction project

Code	Designation	Years of experience	Role within the organisation
R12	Deputy Project Manager	Total 35 years in construction industry. Over 15 years up to date at Project C organisation.	Overall responsible person for construction at Project C organisation.
R13	Planning Engineer	Total 24 years in construction industry. Over 16 years up to date at Project C organisation.	Responsible for all the planning works at every stage of construction Project C
R14	Site Engineer	Total 16 years in construction industry. All the 16 years at Project C organisation.	Responsible for managing all the human resources at site level while handling skilled and unskilled labours in lean implementation at Project C
R15	Quantity Surveyor	Total 12 years in construction industry. Over 7 years up to date at Project C organisation.	Responsible for managing the contractual and financial side of the construction project C.
R16	Head of Standard Operating Systems	Total 25 years in construction and 10 years with large scale contractors	Have 15 years' experience in advising for lean implementation in construction and manufacturing organisations.
R17	Project Coordinator	Total 30 years in large scale contracting organisation	Have 20 years' of experience in initiation and sustain lean transformation within the organisation
R18	Operational Manager	Total 25 years in construction and 16 years with large scale contractors	Have 17 years' of experience in lead and manage lean improvement projects in construction industry
R19	Unit Manager	Total 13 years in construction and 13 years with large scale contractors	Have 6 years' of experience in advanced understanding of the contents of lean initiatives including philosophies, principles and techniques
R20	Head-Contract and Procurement	Total 24 years in construction and 20 years with large scale contractors	Have 16 years' of experience in perform in-depth training, coaching of lean principles and techniques.
R21	Senior Lecturer and Quantity Surveyor	Total 12 years in construction and 9 years with large scale contractors	Have 7 years' of experience in develop, link and implement lean initiatives to align and active results within the organisation
R22	Lean Manager	Total 22 years in construction and 18 years with large scale contractors	Have 17 years' of experience in lead and manage lean improvements teams.
R23	Lean pioneer and Head of Overseas Construction	Total 32 years in construction and 25 years with large scale contractors	Have 26 years' of experience in advising in lean implementation in construction in
R24	Head of Construction Management Division	Total 19 years in construction and 15 years with large scale contractors	Have 15 years' of experience in mobilizing lean construction performance team and advising human resources
R25	Managing Director	Total 26 years in construction and 17 years with large scale contractors	Have 17 years' of experience in lead and manage lean improvements teams.
Note:			

Code	Designation	Years of experience	Role within the organisation
Project A		Project B	Project C
Construction of a university building Value: Rs. 2 billion Duration: 1.5 years Implemented lean concept at construction site level		Construction of an apartment building Value: Rs. 6 billion Duration: 3.5 years Implemented lean concept at construction site level	Construction of a high-rise apartment & hotel building Value: Rs. 12.5 billion Duration: 5 years Implemented lean concept at construction site level

The research findings identified regarding the human related challenges in lean implementation, human capacities necessary in lean implementation, advantage of building human capacities in lean implementation and strategies to build human capacities necessary to foster lean construction in large-scale contractors are presented in the below sections. Further, a validation of research model developed by including the aforementioned research findings has also been presented at the end of this chapter.

4.3 Human related challenges in lean implementation in Sri Lankan construction industry

The respondents were questioned regarding the human related challenges affecting the successful implementation of lean concept under different groups of human resources in different hierarchical levels as shown below.

- Managerial level staff
 - Top level management
 - Middle level management
 - Operative level management
- Administrative and operative level employees
- Skilled and unskilled level workers

A summary of collected data from in-depth interviews on the human related challenges affecting the successful lean implementation in large scale contractors are presented under the human resources of different hierarchical levels in Appendix A. Accordingly, the human related challenges highlighted by the respondents under each hierarchical levels have been incorporated in to the first five columns of the table shown in Appendix A. Considering the challenges highlighted by the different respondents, a common terminology has been derived for each challenge in the last column of the table shown in Appendix A. Finally, a cognitive map has been developed illustrating the summarised research findings on human related challenges of lean implementation in Sri Lankan construction industry, which illustrates the common terminologies extracted from Appendix A. Accordingly, Figure 4.1 illustrates a cognitive map developed on human related challenges of lean implementation in Sri Lankan construction industry.

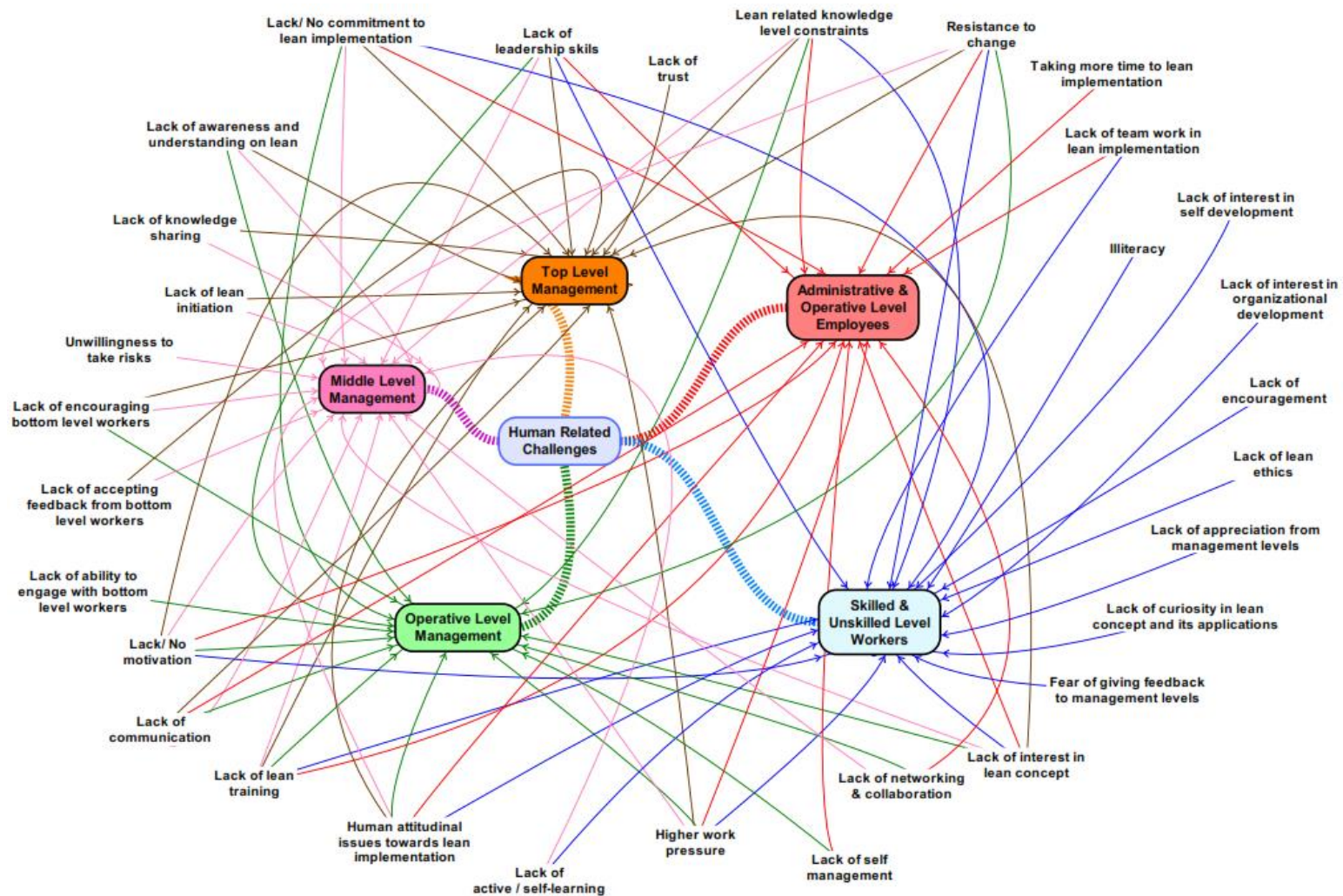


Figure 4.1: Cognitive map of human related challenges in lean implementation of large-scale contractors in Sri Lanka

The summarised human related challenges impacting the successful lean construction implementation as illustrated in Figure 4.1 are described in detail below.

4.3.1 Lack or no commitment to lean implementation

When considering all-human resource levels, lack of commitment to lean implementation is evident since most of the human resources are only focusing on obtaining profit and monetary benefits. Therefore, the commitment must be similarly developed within the human resources of each level in order to successfully implement lean concept. According to R-12, lean implementation is not only a commitment of few individuals but also the whole human resources of each hierarchical level in an organisation. Hence, middle and operative management level employees' commitment is crucial in lean implementation, since they can either avoid or enable the implementation procedure as middle managers are dealing with the skilled and unskilled level workers who are actual practitioners of lean implementation on a daily basis. Even the commitment of administrative level employees is also necessary for the successful lean implementation while the commitment of skilled and unskilled level workers is playing a major role. When considering the global context, Datta (2012), Chesworth (2015), and Brady et al. (2011) have also highlighted the impact of lacking commitment of human resources from top and middle management level employees and skilled and unskilled level workers in successful lean implementation. Moreover, Sarhan and Fox, (2013) also highlighted the lack of commitment as one of the major challenges of lean implementation significant to top management level in lean implementation in global context.

4.3.2 Lack of leadership skills

Lack of necessary leadership skills to successfully implement lean construction is another major challenge, which is impacting all the human resource levels in various aspects. Applying necessary leadership skills in lean implementation have been identified as one most effective way of sustaining and improving the lean concept within construction industry. Several literature sources such as Datta (2012) and Chesworth (2015) have also highlighted the impact of lacking leadership skills within managerial level employees as one of the major challenges of lean implementation. As per R8, *“according to my opinion, both the transactional and transformation leadership behaviours are expected to be developed within the top and middle level management of construction organisations”*. Thereby, R4 highlighted that Sri Lanka being a developing country is necessary to have effective line of managerial level employees to successfully implement the lean construction. Similarly, the literature has identified the lack of managerial skills such as leadership skills as a major challenge in under developed countries as well (Bajjou & Chafi, 2018).

4.3.3 Lean related knowledge level constraints

According to R16, when considering each level of human resources, knowledge level constraints are one of the major challenges. According to R5 *“when particularly consider the top-level management in the aspect of required knowledge level for lean implementation, majority in Sri Lankan construction industry are very poor”*. Thereby without lean knowledge of top management, lean initiation and implementation from middle management level employees to bottom level workers would be unrealistic. Lack of knowledge on lean implementation is a major challenge affecting the administrative and operative level employees, and skilled and unskilled level workers as well. The aforementioned challenge of lacking knowledge and understanding within skilled and unskilled level workers have also been highlighted by Mann (2014). According to R8, *“majority of the bottom level workers do not have the capacity in identifying the importance of continuous improvement, impact of non-value adding activities, and tools and techniques used in lean implementation process”*. Thereby, the involvement of skilled and unskilled level workers in the lean implementation is at unsatisfied level. Similarly, limited and inadequate awareness in lean concept within human resources representing each hierarchical levels have also been highlighted by Abdullah et al. (2009), particularly in developing countries.

4.3.4 Lack of knowledge sharing

According to R2, the nature of not sharing the existing knowledge of top and middle level management regarding lean construction can also be experienced currently in the large-scale contractors due to several reasons. R16 emphasised that the capability of top-level management to share their knowledge regarding lean implementation leads in enhancing the performance of the other human resources in the working environment, which also produce the organisation to develop skills and competencies, increase value and sustain their competitive advantage. However, the causes for lack of knowledge sharing on lean construction in large scale contractors have been highlighted by R1, R8, and R14 such as trust issues, interpersonal attitudes, diversity, and specifically the size of construction team. Similarly, Chesworth (2015) has highlighted the necessity of top management to share the knowledge and their experiences with the subordinates to enhance the lean implementation in global context.

4.3.5 Lack of lean initiation

According to R7, *“top level management can drive the lean initiation, since they are the people whom always taking the strategical decisions of a construction organisation”*. For an example, top level management can decide that Last Planner

System (LPS) should be implemented in each construction project that they are undertaking. In such situation, each human resource in that particular organisation needs to adapt lean even if they do not prefer. However, lack of initiation from top level management is considerably affecting to the successful lean implementation.

4.3.6 Lack of motivation or encouragement of bottom level workers

Lack of motivation or lack of encouragement is another major challenge, which is indirectly related to skilled and unskilled level workers in lean implementation. In order to achieve the success in lean implementation, the fully engaging and committing nature of the human resources representing each level is equally important. According to R4, *“majority of the bottom level workers are being demotivated to be engaged in innovative concepts such as lean construction in the instances of feeling under-valued or when the monetary benefits being the major objective of workers”*. Further, this can be due to the top management is not paying attention to motivate or encourage the bottom level workers by providing recognition, appreciation, and development opportunities to them. Thereby, the motivation of skilled and unskilled level workers is essential for the successful lean construction implementation whereas the nature of motivating and encouraging the bottom level workers is considerably important. The aforementioned challenge has also been highlighted in the literature sources as not providing rewards or benefits to the bottom level workers besides the normal wages giving to them (Bashir et al., 2015).

4.3.7 Lack of accepting feedbacks from bottom level workers

When considering giving and accepting feedbacks with respect to the communication between human resources, the reluctance of top management to accept the feedbacks from bottom level workers can be identified. This can be incurred since the top-level management is being so much preoccupied, which made them not to listen to what others are saying or their opinions. According to R17, *“when considering the middle level managers, lack of obtaining work procedures related feedback from operative level managers, administrative and operative level employees and skilled and unskilled level workers can be highlighted”*. Moreover, it can be observed that the skilled and unskilled workers have fear of sharing their feedback with the managerial level employees including top, middle, and operative level managers on lean implementation. Several literature sources have highlighted the importance of proper communication chain between human resources in lean implementation in global context (Gao & Low, 2014). However, considering the Sri Lankan context, lack of accepting feedbacks received from bottom level workers have been specifically highlighted by the majority of the respondents.

4.3.8 Lack of listening to bottom level workers

In most of the situations, the top management is trying to depending on the opinions of middle and operative level management in making decision rather than listening to the opinions of skilled and unskilled level workers, whom playing a major role in lean implementation. But lean is not a technique, which only the managerial levels can implement. According to R18, *“for example, managerial levels always have to go for “Gemba” technique and consider the opinions and ideas of skilled and unskilled level workers since they are the human resources who are working in the site level”*.

4.3.9 Lack of communication

Another challenge of lean implementation can be identified as not having a proper communication chain in between the human resources from top hierarchical level to bottom hierarchical level. In construction industry, a vertical hierarchy can generally be observed rather a horizontal hierarchy. Thereby, the opinions and shared information from the managerial level employees are not fully communicating to the administrative and operative level employees and skilled and unskilled level workers. Therefore, the poor communication chain or communication gap between the human resources in the perspective of lean construction is another major challenge for all human resource levels. When considering the middle level managers, lack of proper communication to top level management with related to the lean implementation tools, techniques and principles can also be identified as a major challenge. According to R8, *“this can be more specifically highlighted as not conveying the strategically focused plan to be taken by the middle level management regarding the lean implementation, which eventually cause for aborting the lean initiative”*. Hence, the large-scale contractors would have to face the consequences in waste of time, energy and money. Similarly, the literature sources have also highlighted lack of communication as one of the major challenges impacting to lean implementation in global construction industry (Bashir et al., 2015; Dulaimi & Tanamas, 2001).

4.3.10 Resistance to change

The nature of resistance to change encompassed within the human resources of each hierarchical level is a major challenge, which is directly impacting for the successful lean construction implementation. Top level management is hesitant to adapt to altered circumstances within an organisation due to either organisational or individual reasons. As per R16, *“one of the primary reasons, which the top management resist to change is the curiosity regarding the value that brings to the company with the implementation of lean construction”*. Further, according to R1, there can be several causes for the nature of managerial level employees to avoid changes such as lean

implementation to a particular construction company due to time constraints, being already comfortable enough with the existing practices, feeling fear of failing due to lack of skills or abilities and not seeing any personal benefit in such practices. Similarly, several literature sources have also highlighted the aforementioned challenge as the unwillingness of management level employees to adapt in new concepts and systems within the construction industry (Abdullah et al., 2009; Bajjou & Chafi, 2018).

Administrative level employees have the ability of using lean practices in several ways. According to R6, *“the marketing department of a large-scale construction organisation can inherit the benefits of lean implementation as a marketing tool that will attract the client base in the industry”*. Further, R6 highlighted that using such techniques by administrative level employees can hardly be seen within the Sri Lankan construction industry. The resistivity towards the lean construction implementation remains same within the skilled and unskilled level workers as well. According to R2, *“this can be seen very often since skilled and unskilled workers are only concern about the monetary benefits that they could obtain rather than experiencing innovative working processes”*. The similar challenge has also been highlighted for the skilled and unskilled level workers as resistance to change in the working culture by Bashir et al. (2015) to the global context.

4.3.11 Human attitudinal issues

Human attitudinal issues in lean implementation have been highlighted as another challenge by majority of the respondents. Human attitudes towards the implementation of lean practices would be directly related to the initial perception, which the human resources would get from the initial changes inherited within the working environment. According to R9, *“the positive attitudes produce within human resources due to the changes of lean implementation such as comfort and well-being would also determine the individual perception on the success of lean implementation”*. Thereby, the positive attitudes towards lean implementation are necessarily to be encompassed within the human resources at each hierarchical level within the large-scale construction organisation. When considering the global context, human attitudinal issues has been highlighted as one of the major challenges of lean implementation related with the human resources in large scale contractors (Johansen & Walter, 2007; Common et al., 2000).

4.3.12 Lack of active learning or self-learning

With respect to the challenge of knowledge level constraints, the respondents highlighted lack of self and active learning as another human related challenge towards the successful lean implementation. Moreover, R2 emphasised that *“human resources*

are losing the opportunities to active or self-learning due to the higher workload and work pressure upon them". The respondents such as R1, R7, and R11 have specifically highlighted this challenge to the middle level management employees and skilled and unskilled level workers. Similarly, many literature sources have also specifically highlighted the importance of active learning on lean by involving practically to the skilled and unskilled level workers (Bajjao & Chafi, 2018).

4.3.13 Lack of networking and collaboration

According to the majority of respondents, the collaboration and teamwork driven by the lean implementation particularly supports in reducing waste of time, material, motion and human efforts within the whole lifecycle of a construction project. Further, R17 emphasised that networking and collaboration has the potential to provide an opportunity for large scale contractors to involve in innovative trends and technologies available in the construction industry. Therefore, lacking the networking and collaboration within human resources in large scale contractors can be identified as one of the major challenges impacting the successful lean construction implementation. Similarly, Ranadewa et al. (2018) have also been highlighted lack of networking and collaboration as one of the major challenges of lean implementation related to the human resources.

4.3.14 Lack of ability to engage with bottom level workers

Operative level management is the first line management who oversee the work done by the labour force and supports bottom level workers in carrying out construction work. According to R3, *"the proper operative level management must not stand above the team, but essential to be a part of team by engaging their bottom level employees in right direction while developing the employees"*. Therefore, lacking the ability of engaging with the bottom level workers in operative level management employees has been highlighted as one of the challenges of lean implementation. Moreover, this challenge impacting to successful lean construction implementation has been specifically highlighted to the Sri Lankan context by the respondent R17.

4.3.15 Lack of team work in lean implementation

Human resources of each level within a lean organisation are focusing on a common goal of achieving continuous improvement, waste reduction, and maximising value. Therefore, each human resource within lean organisation requires to working on reaching this common goal as a one team irrespective of their professional hierarchical level. R19 highlighted that *"it is the obligation of middle and operative management level employees to provide guidance to their bottom level workers and to develop them by being on familiar terms with each other and work together as a team"*. Therefore,

lacking the team working ability in middle and operative level management employees, administrative and operative level employees, and skilled and unskilled level workers is one of the major challenges for successful lean implementation. The similar challenge of lack of teamwork between the human resources of a construction organisation has also highlighted by several literature sources such as Ranadewa et al. (2018), Alarcon et al. (2001), and Madanayake (2015) both in global and Sri Lankan contexts.

4.3.16 Illiteracy

According to R11, most of the skilled and unskilled workers in the Sri Lankan construction industry are uneducated and illiterate. More comprehensively, R9 stated that *“illiteracy is a huge issue in successful lean implementation. For an example, assume that each bottom level worker is required to provide feedback to the last planner system while the majority of workers are illiterate. Thereby how can we expect them to write down feedback on a sticky note”*. Even though the managerial level staff is necessary to drive and initiate the lean implementation, skilled and unskilled level workers are necessary to understand the principals and methods of successful lean implementation. Therefore, the illiteracy has been identified as another human related challenge affecting to successful lean implementation with reference to the skilled and unskilled level workers.

4.3.17 Lack of lean ethics

Lack of lean ethics is another critical challenge, which is relating to all the levels of human resources from top management to the skilled and unskilled level workers. In order to successfully implement lean construction in particular organisation, a company need to fully adopt and implement the company’s code of ethics which needs to be necessarily derived from the managerial level staff. According to R13, *“lean and ethics need to walk side by side where the organisations need to completely adapt and apply the company’s code of ethics”*. In summary, this issue can be referred to as lack in developing the culture, which creates the involvement of each human resource in an organisation including managerial level staff to the skilled and unskilled level workers.

4.3.18 Lack of curiosity in lean concept and its applications

Curiosity is a key for an individual to explore new things, cope with changes, and work on innovative processes. Moreover, the curiosity leads the individuals to open more to the other peoples’ opinions, emotions, and their reactions. According to R10, *“the skilled and unskilled level workers in construction industry are not encompassed with curiosity at all in Sri Lankan construction industry”*. The skilled and unskilled level

workers neither have interest nor any requirement to learn or engage in the implementation of innovative concepts such as lean construction. According to R17, lack in curiosity might be caused due to the lack of involvement of the workers within an organisation. Similarly, Brady et al. (2011), have also emphasised the impact of lack of curiosity of workers in lean implementation.

4.3.19 Other Human Related Challenges

Except to the aforementioned challenges of lean implementation, several other challenges have also emphasised by the respondents as described below. Accordingly, the trust issues have been highlighted as another challenge to lean implementation by R1. Moreover, R1 emphasised that trust issues are generally rises within human resources due to the nature of resistance to change. According to R16, *“higher work pressure is another challenge, which is impacting to all levels of human resources in successful lean implementation”*. Human resources from top managerial levels to bottom levels workers are burning from several work-related issues, personal issues, and time constraints. Due to the above circumstances, the human resources have no mindset to adopt for new approaches. More significantly, Bashir et al. (2015) have highlighted the similar challenge of higher work pressure for administrative and operative level workers due to the complexity of practicing lean in administrative activities.

Further, R16 highlighted lack of interest in organisational and self-development as another major challenge of skilled and unskilled level workers for successful lean implementation. According to R2, the interest of skilled and unskilled level workers towards organisational and self-development can be achieved through the active learning. Further, lack of appreciation of the bottom level workers is one of the major challenges to lean implementation. According to R5, these appreciations need to be done by all the managerial level staff.

Lack in tapping into the intrinsic motivators of human resources is another major challenge of top management level employees which is impacting the successful lean construction implementation. According to R17 *“rewarding the human resources intrinsically would build a highly committed and motivated workforce within the construction project”*. Moreover, lack of investing in the learning, development, and well-being of the human resources of each level can be identified as one example for such intrinsic values. Similarly, the aforementioned challenge has also been emphasised by Bashir et al. (2015) to the skilled and unskilled level workers namely not providing any rewards beside normal wages. Similarly, lack in providing necessary incentives to the human resources within an organisation has also been identified as another challenge (Datta, 2012).

Another major challenge has been highlighted as the unwillingness in participating training programs of human resources representing each hierarchical levels from top management level to bottom level workers. According to R9, attending to training programs can be identified as one of the major aspects of encouraging and motivating the human resources in involving lean implementation process. Accordingly, the human related challenges of lean implementation in large scale construction projects can be identified as above.

4.4 Human capacities necessary for lean implementation in Sri Lankan construction industry

The respondents were questioned regarding the human capacities necessary for the successful implementation of lean concept under different groups of human resources in different hierarchical levels as shown below.

- Managerial level staff
 - Top level management
 - Middle level management
 - Operative level management
- Administrative and operative level employees
- Skilled and unskilled level workers

The identified human capacities have been categorised in to seven sub human capacity categories namely knowledge, critical thinking, positive attitudes, leadership, communication, team building, and work ethics by considering the previous study conducted on the lean implementation in SMCs in Sri Lankan context as the basis (Ranadewa et al., 2021). Accordingly, a summary of human capacities under the human resources of each hierarchical levels, which affects the successful implementation of lean construction are presented in Appendix B. The human capacities identified by the respondents under the aforementioned sub human capacity categories have been incorporated in to the first five columns of the table in Appendix B. Considering the human capacities highlighted by the different respondents, a common terminology has been derived for each human capacity in the last column of the table in Appendix B. Finally, a cognitive map has been developed illustrating the summarised research findings on human capacities necessary for successful lean implementation in Sri Lankan construction industry, which illustrates the common terminologies extracted from Appendix B. Accordingly Figure 4.2 illustrates a cognitive map developed on human capacities necessary for lean implementation in Sri Lankan construction industry

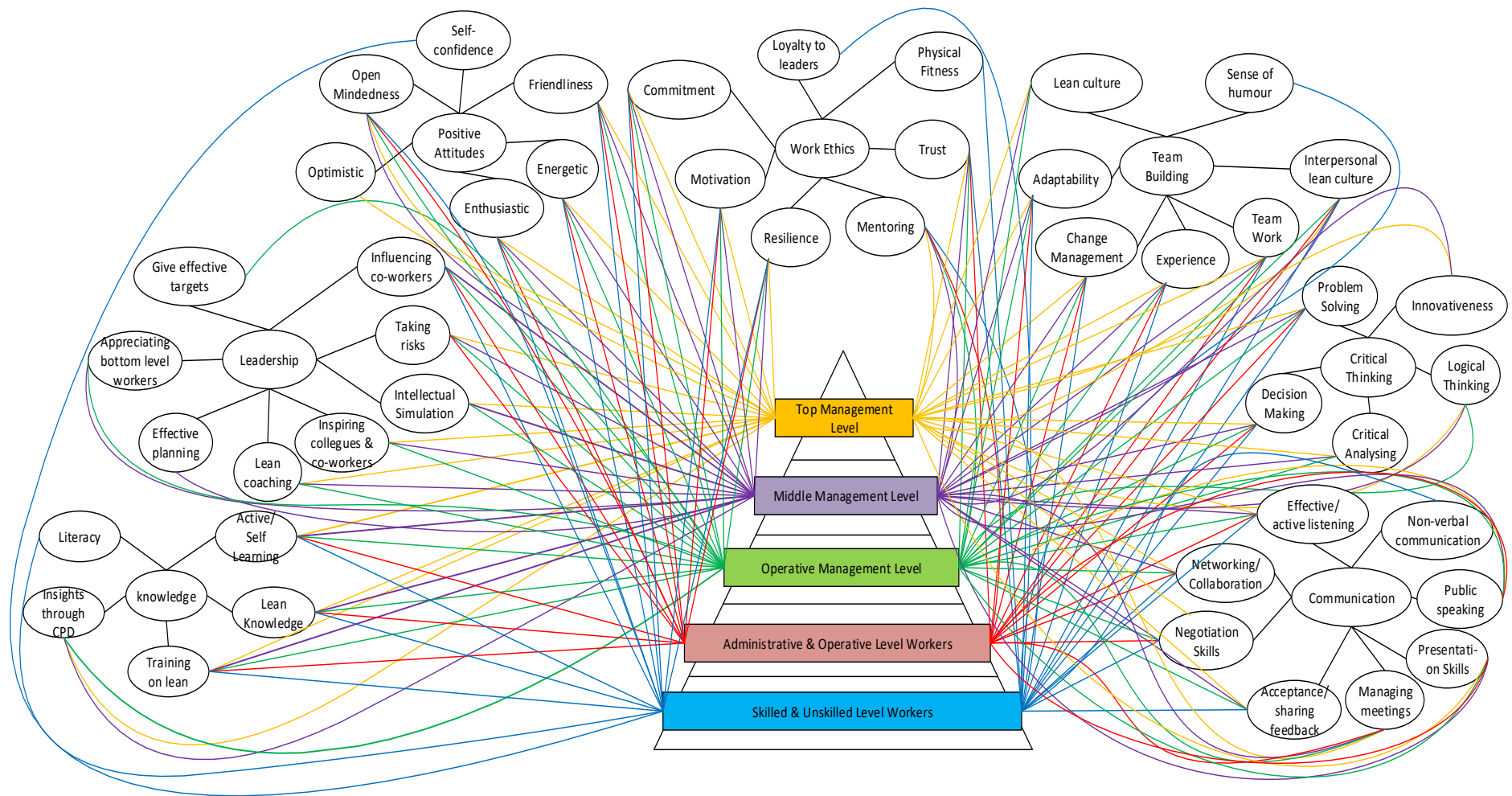


Figure 4.2: Cognitive Map of Human Capacities Necessary in Lean Implementation in Large-scale Contractors in Sri Lanka

The summarised human capacities necessary to the successful lean construction implementation as illustrated in Figure 4.2 are described below. Building human capacities necessary for fostering lean construction is essential since human resources are the main drivers of lean implementation. According to R3, *“government, organisation or the industry as whole are not driving the successful lean implementation, but human resources are the main driver. Therefore, it is essential for the industry practitioners to be aware of which human capacities are required to be developed within the human resources of an organisation”*. The human capacities required for each hierarchical levels have been described under seven sub human capacity categories namely knowledge, critical thinking, positive attitudes, leadership, communication, team building, and work ethics as below.

4.4.1 Knowledge

Lean knowledge

Having a knowledge in lean implementation has been identified as one of the major capacities necessary to be built within the human resources from each hierarchical level in large scale construction organisations. According to R7, the knowledge on lean tools, techniques, and principles is equally required to encompass within all the human resources irrespective of the hierarchical levels. More comprehensively, the R13 highlighted the necessity of relationship of lean knowledge in between managerial level employees and bottom level workers. More comprehensively, R13 stated that *“neither bottom level workers are not in a position to involve in lean implementation without the approval and consent of managerial level employees nor top management would be able to successfully implement lean construction without the support from bottom level workers”*.

Irrespective of that, R15 highlighted that the knowledge level regarding different lean tools would be different with respect to the hierarchical levels of human resources. For example, in the instance of implementing LPS within the construction project, the top and middle level management must have a whole idea and knowledge such as how to implement the LPS or the way of conducting a value stream mapping while the other employee levels does not require that much detailed knowledge since those employee levels are not involving in whole LPS process. The literature sources have been emphasised the necessity of lean knowledge within middle management employees in order to initiate the strategic decisions and plans identified by them (Groot & Molen, 2001). Moreover, the difference of required knowledge level has been highlighted by literature sources. Accordingly, Rymaszewska (2014) have stressed the knowledge requirement on lean principles, tools and techniques for operative management

employees, administrative and operative level workers, and skilled and unskilled level workers.

Training on lean

Training has been highlighted as another important capacity essential to be developed within the individuals of each hierarchical level by respondent R1, R8, and R17. Generally, training and development is encouraging the individuals to improve the individual skills, organisational culture, and enhancing employee productivity. Therefore, R1 highlighted that the top-level management is required to conduct more training programs on lean construction to their subordinate workers while the human resources representing the other hierarchical levels are required to obtain the training programs or workshops available relevant to the lean implementation. Moreover, R18 stressed that *“irrespective of the top management employees, the human resources representing the other hierarchical levels are necessary to attend the training programs on lean concept”*. Similarly, the importance of proper training on lean implementation have been identified as an important human capacity, which can drive the successful lean implementation (Salem et al., 2005; Demirkesen & Tommelein, 2016; Almanei et al., 2017). Contradictorily, Aziz and Hafez (2013) have highlighted the importance of proper training to human resources of each hierarchical level except administrative and operative level workers.

Active or self-learning

Further, R8 highlighted the importance of active learning and self-learning on lean construction, its tools, techniques and principles by the human resources of each hierarchical level. According to R4, *“when the individuals are actively involved in the learning process by themselves, they find an extended opportunity to explore new concepts through discussion, practice, review, and application”*. Therefore, the managerial level employees find the active learning as a very important human capacity to be built in order to explore more on lean construction and its applications. Further, R9 stated that though the nature of active and self-learning of administrative level workers, and skilled and unskilled level workers is considerably low, it is necessary to encourage them to learn more about lean in order to foster lean construction successfully. Similarly, Ranadewa et al. (2019) have highlighted the importance of effectively using the effective opportunities existing in the construction industry to build the human capacity of active or self-learning.

Insights through CPD

Respondents have significantly highlighted the importance of developing the individual insights through participating in Continuing Professional Development (CPD) on lean construction as it provides the top, middle, and operative management

level employees the means to progress their career with knowledge and skills required to shape the lean construction. Similarly, Basil (2005) have stressed insights through CPD as a significant human capacity to be built particularly in managerial level employees.

Literacy

According to R17, a huge gap in basic literacy can be extensively experienced in the skilled and unskilled workforce within the large-scale contractors of Sri Lanka, which does not support the healthier lean implementation within construction projects since skilled and unskilled workforce are the floor level implementers of lean concept under the guidance of management levels employees. Therefore, the necessity of building literacy within the skilled and unskilled level workers in order to foster successful lean construction have been highlighted by R12.

4.4.2 Critical Thinking

Critical analysing

When specifically considering the top and middle level management employees within an organisation, the ability of critical analysis is necessary to be built within them in order to foster lean construction. The ability of critical thinking provides the managerial level employees a tool to make proper decisions and to predict the effects and consequences of implementing lean construction within an organisation. According to R18 *“the management level employees would have the potential to critically analyse the effects and benefits that can be achieved through lean implementation”*. Further, this will also support the middle and operative level management to infer possible ways of dealing with the other employees and bottom level workers in lean implementation where literature sources incidentally agreed both in global and Sri Lankan contexts. Accordingly, Ranadewa et al. (2019) emphasised critical analysis skills as an important human capacity to be developed within managerial level employees since critical analysis and deriving solution in the problem-solving perspective is crucial for continuous improvement.

Problem solving and decision making

Some of the managerial skills such as problem solving and decision-making ability have been highlighted as another important capacities to be built within the managerial level employees of each hierarchical level, administrative and operative level workers, and skilled and unskilled level workers for fostering lean construction. For example, R3 stated that *“it is necessary for the managers in construction to go to Gemba and see the work by themselves, listen and provide support to people who are trying to*

solve problems. This highlights the need of primary focus on developing problem-solving skills of human resources of each hierarchical level". Therefore, the importance of building problem solving skills and thereby proper decision making has been highlighted. However, the aforementioned capacity of problem solving and decision making have only been stressed for the managerial level employees by previous researchers (Nesensohn et al., 2014; Aziz & Hafez, 2013; Koskela, 1992).

Except to the aforementioned human capacities emphasised under the sub category of critical thinking, the respondents have highlighted the importance of logical thinking ability, and innovativeness of top management level employees in order to bring success to the organisation through lean construction implementation

4.4.3 Positive Attitudes

Open mindedness

Some of the respondents such as R4, R17, and R18 have highlighted the importance of having an open mind set of human resources of each level in order to foster lean construction. More comprehensively, the top management is necessary to have an open mind set to accept the opinions and strategic planning of middle and operative level management employees in the perspective of lean construction implementation. R12 highlighted that *"having open mindedness in human resources of other hierarchical levels is equally important in lean implementation in order to adapt to a change within the working environment, encourage teamwork ability, and inspire workplace flexibility in lean implementation"*. The importance of open mindedness has been further proven by Ranadewa et al. (2018).

Optimistic

Further, respondent R1 highlighted the significance of lean leaders and co-workers being optimistic throughout the lean implementation process. Accordingly, R6 stated *"individuals should not count on the financial goals and financial numbers, which looks like they really don't understand lean principles. But they need to keep talking and have faith in the lean process optimistically and they will earn huge returns in many aspects"*.

Enthusiastic, Energetic, and Friendliness

R9 highlighted the requirement of developing human capacities with reference to positive attitudes of individuals irrespective of their designation or hierarchical levels within an organisation. Accordingly, R9 emphasised that *"friendliness as an important human capacity to be built in each individual as each individual is necessary to be collaborated in implementation procedure"*. Thereby, each individual would become

a co-learner and co-creator of the lean implementation process, which encourages human resources to be energetic and enthusiastic in the implementation process. The importance of developing similar human capacities have also been proved by several researchers such as Pavez and Alarcon, (2006), and Enermak and Ahene, (2002).

4.4.4 Leadership

Influencing co-workers

Lean leaders representing all the hierarchical levels of management required to exhibit the behaviours, which encourages the commitment of the other human resources within the whole organisation. However, R18 highlighted the importance of developing the human capacity of influencing co-workers not only within management level employees, but also within skilled and unskilled workers as well. Accordingly, lean leaders should not become command and control leaders, but they need to continuously influence the co-workers to figure the lean journey out together. Hence, the subordinates and co-workers would be both influenced and inspired towards committing to a lean journey. Further R4 highlighted the capability of administrative, and skilled and unskilled level workers as well to influence the co-workers on the lean implementation process. The aforementioned human capacity has been specifically identified by the authors through respondents given by the subject matter experts.

Lean coaching

Lean coaching has been highlighted as another major capacity necessary to be built within managerial level employees. According to R21, whenever the managerial level employees are aware of a new lean tool or technique, it is important to provide lean coaching to the subordinate workers on such knowledge. R7 has highlighted the importance of recognising and appreciating the employees and skilled and unskilled workers in order to encourage the active participation of each individual in creating the lean implementation process. Whilst the literature sources also agreed with the above, Ranadewa et al. (2018, 2019) identified lean coaching as an essential capacity that foster lean construction in Sri Lankan context.

Appreciating bottom level workers and Effective planning

According to R2, “*acknowledgement of the understanding, knowledge, and commitment of each individual is equally important to make the lean implementation process a success*”. Therefore, appreciating bottom level workers have also been highlighted as another important human capacity to be built in lean implementation process in the aspect of leadership. Since the middle level management are the strategic planners in a construction organisation, they need to develop the capacity of effective

planning whereas the operative level management is required to enhance the ability of giving effective targets to the front-line workers to achieve within the lean framework identified by the top-level management of the organisation. Few studies elaborated the appreciating bottom level workers as an important human capacity to be built within managerial level employees (Mossman, 2005). Further, Ranadewa et al. (2018) have also highlighted the necessity of leaders to be accountable and appreciating subordinate workers as a significant human capacity to be developed.

4.4.5 Communication

Acceptance and sharing feedback

Considering the sub capacity category of communication, acceptance and sharing feedback has been highlighted by the majority of the respondents. According to R19, the top management, and skilled and unskilled level workers are required to manage the proper one-way communication in successful lean construction implementation. Accordingly, the top-level management requires to accept the feedback provided from the subsequent bottom levels meanwhile the skilled and unskilled level workers are essential to share the particular feedback relevant to lean implementation. When considering the middle and operative management level employees, and administrative and operative level workers, they are required to manage the proper two-way communication in lean implementation. According to R3, *“operative level management is specifically required to obtain the proper feedback from the skilled and unskilled level workers at the floor level while providing the advice and guidance required for the lean construction implementation”*. This has been further proven by Ranadewa et al. (2018, 2021) as accepting and sharing feedbacks is a necessary human capacity to be developed within human resources from top management to skilled and unskilled level workers to successfully implement lean construction.

Networking and collaboration

Further, the importance of networking and collaborative communication has been highlighted by the majority of respondents as a crucial human capacity to be developed within human resources of each hierarchical level. According to R15 *“collaborative communication, which would be combined with the visual management provides the human resources to understand the lean implementation process in an effective manner, keeps the lean team aligned together, and builds a lean culture”*. Further, when involving in the collaborative working environment, the team members are encouraged to actively listen to the ideas, methods and processes proposed by the top management in the perspective of lean implementation. The current study has identified the importance of networking and collaboration for the human resources of each hierarchical levels with respect to the successful lean construction

implementation. However, Mossman (2005) has emphasised the significance of collaborative management specifically to the managerial level employees.

Other human capacities

In addition to the aforementioned human capacities with reference to communication, R1, R8, and R20 highlighted the necessity of encompassing several capacities such as managing meetings, presentation skills, and public speaking within top, middle, and operative level management to foster lean construction in large scale construction projects.

4.4.6 Team Building

Building interpersonal lean culture

With respect to the team building within the lean construction project, the majority of the respondents highlighted the importance of building the interpersonal lean culture. Generally, a lean culture within an organisation encourages the individuals to quickly respond for continuous improvement, adhering to a collaborative learning environment, and contributing the individual opinions in lean implementation. However, when considering the perspective of building human capacities, it is necessary for the individuals to build the lean culture within them. The literature sources have also emphasised the necessity of developing lean culture within an organisation in order to enhance the change towards the leanness. Accordingly, Emiliani (2006) have highlighted the importance of building lean culture to enhance the lean thinking of human resources, continuous improvement and respecting each human resources. Further, Ahmad and Ismail (2017) have also highlighted the necessity of constant interplay between lean culture and managerial level employees of construction organisation.

Team work

Under team building, work as a one team in the lean journey is an important aspect to be built within the human resources representing each hierarchical level of an organisation. In large scale construction projects, the number of human resources is considerably high, which encourages the involvement of many individuals within the lean journey. However, many leaders imagine that lean is only for the front-line workers, but not for the executives. Therefore, it is important to ensure the involvement of each human resource towards a lean implementation journey within an organisation. According to 5, *“the executives can also be included in the team as front line through using 5S techniques to keep their offices clean, clear and organised, using visual management devices in the executive areas, and identify waste and eliminate*

them". Similarly, the importance of building aforementioned capacity within human resources has also been proved by Tezel et al. (2017).

Adaptability, change management and sense of humour

According to R4, adaptability and change management is necessary to be developed within human resources from each hierarchical level in order to avoid the nature of resistance to change that lies within the human resources. Further sense of humour can also be considered as another human capacity to be built within the individuals, which encourages the team building necessary for lean construction implementation. Research findings of Ranadewa et al. (2020) highlighted the aforementioned human capacities such as change management and sense of humour to the Sri Lankan construction SMEs.

4.4.7 Work Ethics

The respondents have highlighted the significance of work ethics with reference to the successful lean construction implementation. According to R17 *"the employees with strong work ethics would place a higher value either on their professional success or success of lean construction implementation"*. The majority of respondents emphasised several human capacities to be developed such as trust, commitment, and motivation by the human resources from each hierarchical level to foster lean construction where literature from Ranadewa et al. (2020) incidentally agreed and proved the importance of trust, commitment and managerial level motivation towards bottom level workers in successful lean construction implementation. More comprehensively, R11 stated *"when the problem-solving skills are used in the Gemba, the top-level employees or front-line workers are required to take out the fear of workplace skills and necessary to be replaced with trust"*.

Further, mentoring is another capacity, which is necessary to be built by top, middle and operative level management to foster lean construction. According to R4, having leaders as mentors would be one of the best possible ways to successfully encompass the knowledge on lean construction concepts within the human resources of large-scale construction projects. Moreover, the significance of developing the human capacities of loyalty to leaders and physical fitness within skilled and unskilled level workers have also been emphasised by the several respondents such as R4, R8, R11. Accordingly, the human capacities necessary to be built for the lean implementation in large scale construction projects can be identified as emphasised above.

4.5 Advantages in building human capacities necessary for fostering lean in Sri Lankan construction industry

The respondents were questioned regarding the advantages that can be gained by large scale contractors in building human capacities necessary for the successful implementation of lean concept under different groups of human resources in different hierarchical levels.

A summary of collected data from in-depth interviews on the advantages in building human capacities necessary to foster lean implementation in large scale contractors are extensively elaborated under the human resources of different hierarchical levels in Appendix C. Accordingly, the advantages highlighted by the respondents under each hierarchical levels have been incorporated in to the first five columns of the table in Appendix C. Considering the advantages highlighted by the different respondents, a common terminology has been derived for each advantage in the last column of the table in Appendix C. Finally, a cognitive map has been developed illustrating the summarised research findings on advantages in building human capacities necessary to foster lean implementation in Sri Lankan construction industry as shown in Figure 4.3.

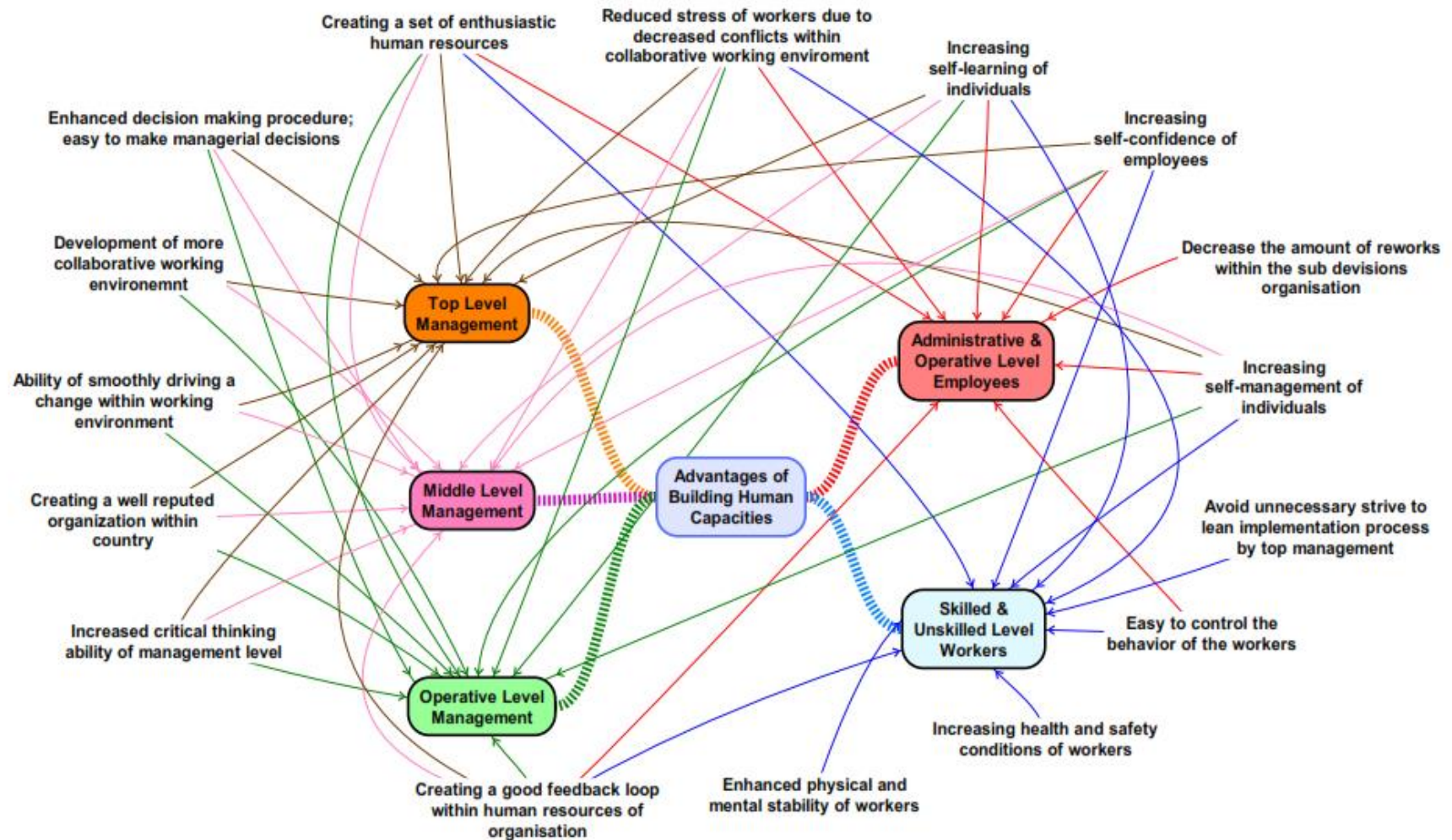


Figure 4.3: Cognitive Map of Advantages of Building Human Capacities necessary in Lean Construction Implementation

According to R1, human resources are the major driver of lean implementation and lean construction requires changes in individual behaviour as well. Therefore, building human capacities encourages the successful lean construction implementation.

According to R5, *“building human capacities of top, middle, and operative level employees enhance the ability to achieve several strategic advantages”*. The decision-making procedure of a construction project would be more enhanced and easier due to the improvement of some human capacities such as critical analysis, logical thinking, problem solving, and decision-making skills. Further, a more collaborative working environment would be developed within the construction project since the development of some human capacities such as networking, collaboration, and team work. Building a collaborative working environment benefits the lean teams to share the opinions, skills, and competencies in order to achieve a common goal. Similarly, literature sources have been elaborated the ability of building coordinated and a peaceful atmosphere in the working environment (Hartline & Bejou, 2012). Another advantage of building human capacities has been emphasised by R7, namely enhancing the ability of smoothly driving a change within a working environment. Change management has the potential of minimising the resistance to change, which also improves the productivity, quality and morale of the employees. Similarly, Hagel et al. (2020) highlighted that, human resources would be able to move away from routine performances and to adopt with the new approaches established within working environment.

Moreover, creating a well reputed organisation within the Sri Lankan construction industry can be identified as another major advantage of building human capacities within the managerial level employees. Since the lean concept encourages the timely delivery of construction projects within the budgetary requirement, the customer satisfaction would be considerably high. Therefore, the higher customer satisfaction directly impacts the long-term success of a company, which directly impacts the higher reputation within the industry. Further, the ability of establishing the higher reputation have also been highlighted in the literature through the achievement of higher profitability to the organisation and as well the long-term benefits to human resources (Gul et al., 2012). Moreover, R3 highlighted that *“the lean implementation in the construction industry in Sri Lankan context is still at the initial stages stage. However, if there is any possibility of building up relevant human capacities, and implement lean, all the other organisations will consider this as a well reputed organisation, which would allow them to being a lean trainer in the construction industry”*. The aforementioned advantages of building human capacities were highlighted specifically to the top, middle and operative management level employees.

Further, the advantages that can be achieved due to human capacity building of the human resources representing each hierarchical level as also been emphasised. Accordingly, creating a enthusiastic set of human resources within an organisation was highlighted by R2. Since the several positive attitudes such as open mindedness, optimism, energetic, and enthusiasm are encouraged to be developed within each individual in an organisation to foster lean construction, they tend to be highly enthusiastic. The enthusiastic nature of human resources benefits an organisation to achieve higher labour productivity and directly shape the quality and speed of work at construction sites. Similarly, some literature sources have also proved the aforementioned advantage. Accordingly, the possibility of developing proper relationship among human resources from each hierarchical level have been highlighted (Hartline & Bejou, 2012). Further, creating a collaborative working environment would benefit the human resources of each hierarchical level in reducing the stress level of the workers. Due to the nature of collaboration between the human resources of an organisation, the motivation and the energy level of the individuals are increasing, which causes in reducing the stress in themselves. The aforementioned advantage has been highlighted by Hagel et al. (2020) as creating a win-win environment for human resources, which allow them to enhance their own performances. Further, the nature of developing adaptability of individuals and proper change management also causes for the stable and less stressful workforce within an organisation.

Another major advantage of human capacity building in lean construction implementation is increasing the self-learning ability of the human resources in the industry. The curiosity that rises within the human resources regarding the lean tools, techniques and principles encourage the individuals to explore more knowledge on lean construction. Similarly, literature sources highlighted that, human resources would be able to obtain proper training with respect to the skills that are required in lean implementation and also the personal etiquettes (Hartline & Bejou, 2012). According to R6, *“the individuals are being motivated and inspired enough to accept the challenging work environment in order to learn novel concepts by themselves, which would be a significant benefit of building human capacities in lean construction implementation”*. Moreover, increasing self-confidence in employees of each hierarchical level has been highlighted by the respondents as another advantage that can be achieved through human capacity building. Generally, the self-confident person is always in the nature of fulfilling all the duties and responsibilities happily and easily. Similarly, the ability of enhancing the confidence level of human resources within an organisation regarding the future growth success of the organisation have also been highlighted in the previous literature as well by Teixeira and Werther (2013). Moreover, R13 highlighted the smooth and easy implementation of the lean concept

within the construction organisation due to inspiration, appreciation, and influence obtained to each individual through human capacity building.

Further, some of the human capacities, which were highlighted as necessary to be developed such as goal setting, self-motivation, and stress management are generally driving individuals to being self-managed. Increasing the nature of self-management within the individuals of an organisation is another advantage as it allows the human resources to efficiently achieve the professional goals while maximising productivity and workplace performance, which has also been proved in the literature sources as well. According to the capacities to be developed within human resources to foster lean construction, maintaining a proper communication process including sharing and accepting feedback within individuals is a must. Therefore, it allows to create a good feedback loop within the human resources of an organisation, which is another significant advantage of human capacity building in lean construction implementation. The similar advantage of improving communication lines between the human resources within working environment have also been proved by previous researchers namely Hartline and Bejou (2012).

Moreover, R9 highlighted the several advantages that can be achieved through the human capacity building in skilled and unskilled level workers to foster lean construction. Accordingly, due to the enhancement of physical fitness and some other positive attitudes such as an open mind set, optimism, and friendliness the physical and mental stability of workers, and productivity would be enhanced. Similarly, the possibility of performing more productively and effectively has also been highlighted by Hagel et al. (2020). R12 emphasised the ability of increasing health and safety conditions of workers as another advantage that can be achieved through human capacity building in fostering lean construction. Easy control on the behaviour of the workers by the management level employees in an organisation, and reduce the amount of rework within sub divisions of an organisation were some other benefits highlighted by the respondents with respect to the human capacity building in lean construction implementation. The aforementioned advantage has been specifically identified by the researchers through the data collection and analysis. R2 highlighted that *“giving effective targets, teamwork and experience are causing the reduced amount of rework within sub divisions of an organisation which specifically benefits the administrative and operative level workers”*. Accordingly, the advantages that can be achieved through human capacity building in lean construction implementation can be briefly described as above.

4.6 Phase II – Data Collection, Analysis and Findings

In Phase II of data collection, in-depth interviews were conducted with ten lean experts who were selected in phase I from large-scale construction organisations including construction industry lean implementers, lean trainers and lean academics. In this phase, the experts were questioned regarding the strategies for building human capacities to foster lean in Sri Lankan construction industry using the semi-structured interview guideline given in Appendix F. The profiles of the respondents of selected experts are R15 to R25 as elaborated in Table 4.1.

4.7 Strategies for building human capacities to foster lean in Sri Lankan construction industry

The respondents were questioned regarding the strategies for building human capacities to foster lean in Sri Lankan construction industry under different groups of human resources (i.e., Managerial, Administrative & operative, and skilled & unskilled levels) in different hierarchical levels.

The summary of the collected data from in-depth interviews regarding the strategies for building human capacities to foster lean construction can be extensively elaborate under the human resources of different hierarchical levels as below. Further, the respondents were questioned to propose strategies under individual, organisational, industrial, and government levels. Accordingly, a summary of strategies to build human capacities for human resources of each hierarchical levels are presented in Table 4.2.

Table 4.2: Strategies to Build Human Capacities Necessary for Lean Implementation

Human Capacities	Strategies to Build Human Capacities Necessary for Lean Implementation			
	Individual Level	Organisational Level	Industry Level	Government Level
Managerial Level Staff				
Top Level Management / Middle Level Management / Operative Level Management				
Knowledge	• Lean coaching • Learning lean by doing • Participate on training workshops and seminars on lean • Learning lean from experts • Conduct individual researching on lean construction • Involve in constant training programs on lean construction	• Arrange practical workshops • Arrange CPD sessions • Provide financial help to attend conference and workshop • Develop Standard Operating Procedure • Adhere international standards to work procedures • Arrange full time lean consultants within site	• Conduct training programs for industry people at concessional rates • Involve international experts on lean training workshop • Arrange workshops and seminars to explain purpose of lean construction. • Establish lean institutions • Produce qualified lean trainers	• Conduct training programs for top level management • Provide financial assistant on research grants relevant to lean • Provide education on lean in higher studies
Critical thinking	• Learning by doing • Should accept feedback from subordinates	• Recruit etiquette trainers to improve professional etiquettes • Arrange steering committee for further development	• Giving recognition for innovators • Giving rewards for lean implementors • Conduct brainstorming sessions	• Giving recognition for innovators • Giving rewards for lean implementors

Human Capacities	Strategies to Build Human Capacities Necessary for Lean Implementation			
	Individual Level	Organisational Level	Industry Level	Government Level
		• Allow opportunity to provide strategical solutions		
Positive attitudes	• Accept feedback from subordinates • Attend specific training workshops on attitude development • Share knowledge on lean with organisation and industry • Share best practices experienced • Enhance self-encouragement	• Maintain a supportive lean culture within the organisation • Show the monetary and non-monetary benefits they can achieve	• Organise workshops and training programs by involving professional trainers or practitioners • Conduct cost benefit analysis on traditional construction and lean construction • Conduct training programs	• Organise workshops and training programs by involving professional trainers or practitioners • Provide tax benefits for the lean implementers
Leadership	• Provide lean coaching to the subordinates • Use existing capacities to involve others • Share best practices experienced • Use the existing resources within an organisation	• Develop functional organisation structure	• Provide awards, rewards and recognition • Conduct leadership training programs • Produce qualified lean trainers	• Conduct training programs and workshops
Communication	• Use simple communication methodology	• Conduct progress review meetings to discuss on lean	• Publish magazines on lean construction implementation	• Conduct training programs and workshops

Strategies to Build Human Capacities Necessary for Lean Implementation				
Human Capacities	Individual Level	Organisational Level	Industry Level	Government Level
		Digitize the communication system	- Show the ability of achieving personal aspiration through collaboration - Conduct training programs and workshops	
Team building	- Building lean culture in their own - Use own experience in managing team work	Conduct entertainment activities	Conduct training programs and workshops	Conduct training programs and workshops
Work ethics	Enhance self-trusting	Introduce cooperate ethics and company ethics	- Conduct award ceremonies to encourage lean implementors - Involve experts in mentoring programs - Conduct training programs and workshops	- Conduct award ceremonies to encourage lean implementors - Involve experts in mentoring programs - Conduct training programs and workshops
Administrative & Operative Level Employees				
Knowledge	- Participate on training workshops and seminars - Learning from experts - Involve in constant training programs on lean construction	Conduct simple workshops and training programs on lean	-	-

Human Capacities	Strategies to Build Human Capacities Necessary for Lean Implementation			
	Individual Level	Organisational Level	Industry Level	Government Level
	• Learning by doing			
Critical thinking	• Analysing possible ways of increase productivity and decrease wastage	• Create some platforms to use the critical analysis skills	-	-
Positive attitudes	• Participate in daily meetings	• Create a set of ground rules to support enhancing positive attitudes	-	-
Leadership		• Provide promotions or appreciation	-	-
Communication	• Use simple communication methodology	• Conduct morning meetings and group discussions on lean implementation	-	-
Team building	• Building lean culture in their own		-	-
Work ethics		• Maintain supportive lean culture	• Involve experts in mentoring programs	• Involve experts in mentoring programs
Skilled & Unskilled Level Workers				
Knowledge	• Learning from experts • Involve in constant on the job trainings on lean construction • Learning by doing	• Provide on the job training programs	-	-
Critical thinking	• Try to find solutions by own for simple problems	• Encourage to provide simple solutions	-	-

Human Capacities	Strategies to Build Human Capacities Necessary for Lean Implementation			
	Individual Level	Organisational Level	Industry Level	Government Level
Positive attitudes	• Build the self-confidence by own	• Provides rewards/ salary increments • Concern on individual welfare	-	-
Leadership		• Provide promotions such as gang leadership	-	-
Communication	• Use simple communication methodology • Participate in daily/ morning meetings	• Conduct morning meetings and group discussions on lean implementation	-	-
Team building	• Building lean culture in their own	• Encourage them with rewards and recognition • Accept the opinions and ideas • Show the potential benefits of team work in lean implementation	-	-
Work ethics		• Feed ethical behaviour through fine system • Provide welfare facilities	• Involve experts in mentoring programs	Involve experts in mentoring programs

According to the above table, the strategies to build human capacities to foster lean construction can be described more under individual, organisational, industry, and government levels as below.

4.7.1 Individual level strategies

In order to improve the knowledge of managerial level employees, it is necessary for them to attend the training programs and workshops on lean implementation conducted by different organizational and governmental bodies. When specifically considering the operative level management employees in the perspective of training, R21 highlighted that this management level needs to participate in training programs more constantly than the top and middle level management. That is due to the fact that operative level managers are the immediate supervisors of the bottom level workers, who are labouring in implementing lean. Further, the respondent R16 highlighted the importance of the involvement of managerial level employees in lean coaching to share the knowledge that they have on lean construction implementation with the subordinate and bottom level workers. Another important individual level strategy suggested by respondents is to foster learning by doing within the working environment. According to R18, *“the managerial level employees can be responsible enough to implement lean tools and practices whatever they learn. At least they must try to implement such practices”*. Another main strategy has been emphasized as sharing knowledge on lean implementation and sharing the best practices that each managerial level employee is aware of on lean implementation in order to build the knowledge levels of human resources within the organisation and even within the industry. Further, sharing best practices would support the human resources representing each hierarchical level in shaping the work ethics such as motivation, trust and commitment of individuals. Moreover, learning on lean implementation in the construction industry from a lean expert has been emphasised as another significant strategy to develop each human capacity categories of all the human resources within an organisation. When considering the knowledge level enhancement of skilled and unskilled level workers, it is necessary to provide on the job training for those individuals on the simplest ways and means of involving in lean implementation. Further, the respondents have highlighted that it will encourage the skilled and unskilled level workers in building some other human capacities such as positive attitudes, team building, logical thinking and even communication as well.

When considering the critical thinking perspectives, the more managerial level employees making decisions on lean implementation enhances the more decision-making ability of the managerial level employees. The top management level employees are necessary to accept the feedback provided from the individuals at the subsequent hierarchical levels, which enhance the positive attitudes, and knowledge

levels of individuals on lean implementation. According to R25, it is considerably difficult to change the attitudes of the top management level employees, thereby the top management is necessary to accept the feedback and involve more in team working in order to encompass the positive attitudes within them. Further, the majority of the respondents highlighted the ability of conducting some training programs or workshops to develop the positive attitudes of individuals representing the human resources from all the hierarchical levels. Another important strategy has been identified as monitoring and reporting on how positive attitudes are to be developed. According to respondent R25, *“each management level employee is necessary to share the best practices that they are aware of on lean implementation such as what were the successful practices and failed practices you have already experienced in lean implementation”*. Then only continuous improvement can be achieved, which is one of the main principles of lean implementation, which contributes to developing positive attitudes. Further, sharing best practices would be another significant strategy, which enhances the trust and self confidence levels of each individual within an organisation.

Further, lean coaching can be considered again as a potential strategy to develop the leadership capacities as well of managerial level employees since this will encourage many leadership capacities of individuals such as inspiring and influencing co-workers and bottom level workers. Another specific strategy that can be proposed for the top management level employees to develop the leadership capacities is to use the existing human resources within an organisation. According to R24, *“rather than hiring the new human resources for the position of lean leaders in a particular organisation, the top management can choose the existing and potential middle or operative level management employee instead in order to initiate the lean implementation”*. Moreover, the respondents highlighted some other strategies such as building lean culture in their own and using own experience in managing team work as potential strategies to build the team building human capacities in the human resources of each hierarchical level.

4.7.2 Organisational level strategies

The organisations are required to arrange the practical workshops, training programs, and CPD sessions on lean practices, tools and techniques to the management level employees within the organisational boundaries in order to enhance their knowledge. In addition to that, respondent R19 highlighted the possibility of organisations to support the managerial level employees in financial means to attend the lean workshops, training programs or conferences organised by either international organisations, industry bodies or the government. Further, the respondent highlighted that *“conferences are the best ways for the individuals to grab the knowledge from the research recently carried out as they are addressing the problem existing within the construction industry for real”*. Moreover, in order to achieve the higher level of

productivity and continuous improvement through lean implementation, the respondents have highlighted the recruitment of full-time lean consultants at the site level. Therefore, the effective implementation of lean practices is encouraged.

In order to enhance the critical thinking ability of the managerial level employees, the organisations can conduct etiquette training programs by involving the professional trainers as resource persons. Further, respondents have highlighted another strategy as allowing the operational management level employees to provide strategic solutions to particular concerns that they experience in the site level to enhance their critical thinking ability. Maintaining a supportive lean culture within the organisation by the management level employees would highly encourage to build the positive attitudes of human resources within an organisation. According to R21, *“assume one of the perspectives of manifesting principles, such as the existence of no blame culture within an organisation. It will automatically support in building many positive attitudes such as enthusiasm, self-confidence, energy, and optimism”*. Therefore, building a supportive lean culture within an organisation can be considered as one of the main strategies to build positive attitudes of managerial level employees.

In order to develop the leadership capacities of managerial level employees, the organisations can conduct the leadership camps, which encourages the lean coaching, and initiate lean by doing. Moreover, to enhance the capacities related to communication, the respondents have suggested conducting progress review meetings to discuss lean implementation and digitize the communication chain within the construction project. Further, the respondents have highlighted conducting some entertainment activities, providing rewards, appreciation, and recognition as another strategy for the human resources of each hierarchical level to encourage the positive attitudes, leadership, team building and work ethics of individuals.

4.7.3 Industry level strategies

Industry bodies such as CIDA and professional institutions need to conduct the training programs or conferences for the human resources representing different construction organisations at concessional rates, which encourages the large numbers of individuals to participate. Further, several industry bodies can enhance the involvement of resource persons specific to lean construction from the global construction industry. According to respondent R16, *“it is the responsibility of the construction industry to involve industry specific resource persons rather than government, as government needs to focus on more than one industry as whole. For an example, once the chamber of construction was able to conduct a workshop on lean construction by involving Iris D. Tommelein as the resource person”*.

In the perspective of critical thinking, and work ethics of managerial levels, the industry and government need to contribute their maximum support and recognition to the innovativeness of the managerial level employees, which gives them a value either in monetary or non-monetary basis. Further, the possibility of giving recognition and awards for the lean implementers within the construction industry have been identified as another strategy to build leadership and critical thinking capacities of the managerial level employees. In order to develop the human capacity categories such as team building, work ethics, positive attitudes, communication, and leadership of managerial level employees in the construction industry, the industry is responsible to carry out training programs under each aspect to build the human capacities. According to R17, *“there are several types of training and workshop programs, which the construction industry bodies such CIDA can organise to develop many capacities of human resources. For example, leadership training programs, communication development training programs, and workshops for team building are currently being undertaken by the industry”*. Irrespective of the training programs, the respondents highlighted another significant strategy as conducting small practical workshops for the top and middle management level employees regarding the potential and best ways of lean implementation.

Considering the development of work ethics within the human resources representing each hierarchical level of an organisation, conducting mentoring programs on lean implementation through lean experts as a resource person has been highlighted by the majority of the respondents. The respondents have further highlighted that the aforementioned resource person should essentially be a well-qualified and trained lean expert identified from the industry practitioners. Moreover, in order to enhance the communication capacities of managerial level employees, the respondents have identified the ability of achieving personal aspiration through collaboration.

4.7.4 Government level strategies

Same as at the industry level, the government can also provide concessional rates for the organisations in different ways. According to respondent R20, the financial support provided from the government and construction industry plays a vital role in organisational capacity to organise different workshops and training programs on lean construction. More comprehensively R20 expressed that *“for example, the government can give tax concessions for the organisations that are conducting lean training and workshops, which encourages many organisations to conduct such programs”*. Moreover, the government bodies can also conduct the training and workshop programs to enhance the knowledge levels of the managerial level employees in construction organisations. According to respondent R22, *“South Asian Lean Construction Association has conducted some seminars on lean construction by involving an expert from the USA as a resource person for the large-scale contractors*

in Sri Lanka, which was a huge success in knowledge sharing on global lean exposure”.

Further, the government bodies can allocate resources to the construction industry as a support for the lean implementation, which increases the lean knowledge of managerial level employees. Another strategy to develop the lean knowledge of human resources of top-level management can be specifically highlighted as providing financial assistance to the research grants conducted in the knowledge area of lean construction. Therefore, the aforementioned strategy would support more research and development in the perspective of lean construction implementation. Accordingly, the strategies to build human capacities to foster lean construction can be extensively describes as above.

4.8 Development of research model

Phase I of data collection facilitated to propose human capacities necessary for lean implementation, while Phase II proposed strategies to build human capacities to foster lean construction in Sri Lankan construction industry. Accordingly, the respondents have highlighted the human capacities under seven sub human capacity categories namely knowledge, critical thinking, positive attitudes, leadership, communication, team building, and work ethics. Moreover, strategies have been highlighted by respondents under four levels namely individual, organisational, industry, and government for the human resources of each hierarchical level. Accordingly, a model incorporating the empirical investigation findings was developed. This model is shown in Figure 4.4.

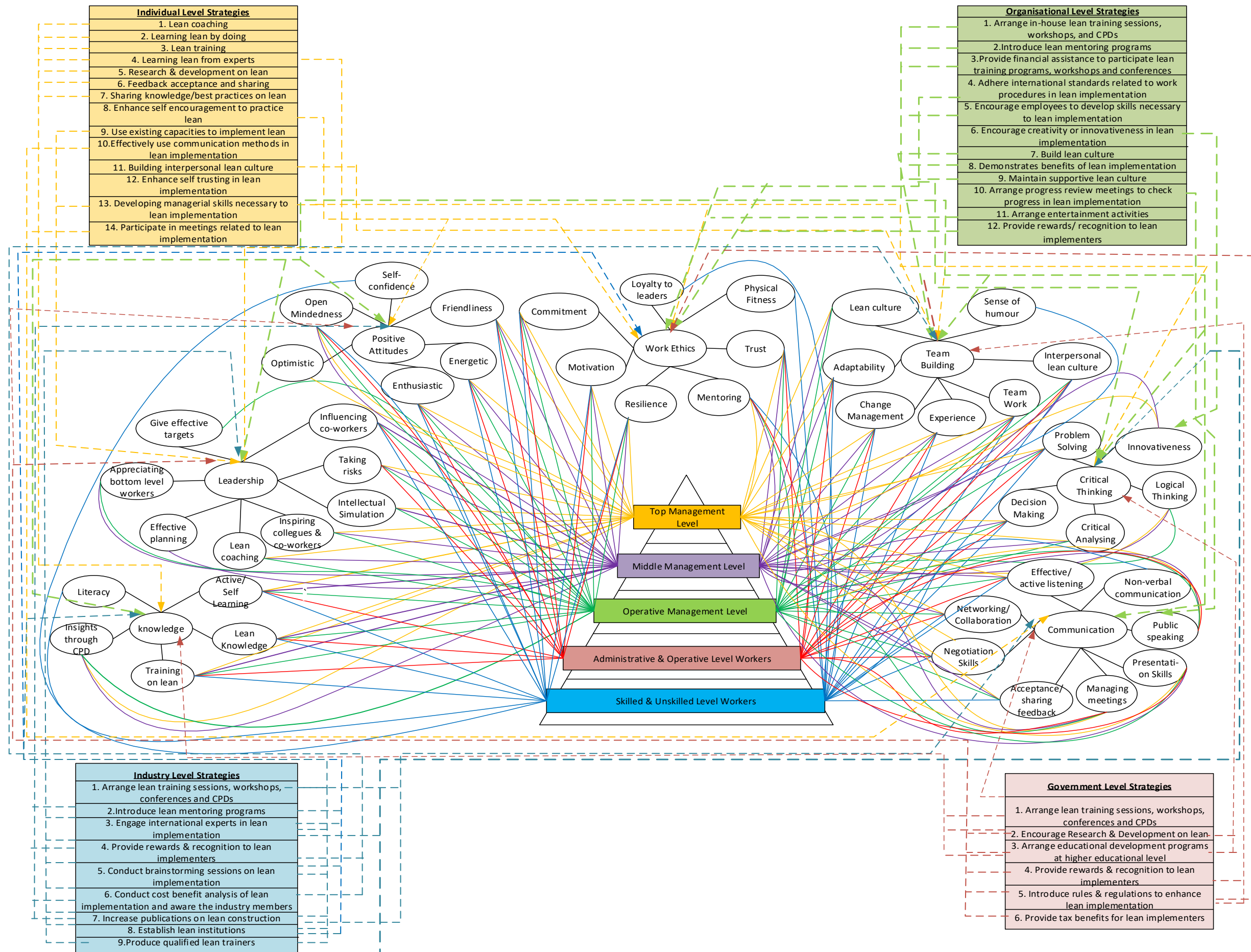


Figure 4.4: Model to Foster Lean Construction Through Human Capacity Building in Large Scale Contactors in Sri Lankan Construction Industry

4.9 Phase III – Validation of the Model

In order to verify and validate the model, it was presented to three (03) subject matter experts who were selected among the previously interviews 10 lean experts in Phase I and II including lean implementers, trainers and academics. Table 4.3 depicts the profiles of the three experts who validated the developed research model. Accordingly, the final research model was refined and developed to foster lean construction through human capacity building in Sri Lankan construction industry.

Table 4.3: Profile of validators

Code	Designation	Years of experience	Role within the organisation
R-V1	Project Coordinator	Total 30 years in large scale contracting organisation	Have 20 years' of experience in initiation and sustain lean transformation within the organisation
R-V2	Senior Lecturer and Quantity Surveyor	Total 12 years in construction and 9 years with large scale contractors	Have 7 years' of experience in develop, link and implement lean initiatives to align and active results within the organisation
R-V3	Lean Manager	Total 22 years in construction and 18 years with large scale contractors	Have 17 years' of experience in lead and manage lean improvements teams.

The experts were satisfied with the research findings on necessary human capacities to foster lean construction in large scale contractors in Sri Lanka. Accordingly, all the human capacities illustrated in the research model presented in Figure 4.4 were accepted and validated by the experts. However, some of the strategies were reworded and some strategies were merged as per the expert opinion. Table 4.4 summarises the revised strategies to build the human capacities necessary to foster lean construction in large scale contractors of Sri Lanka.

Table 4.4: Strategies Revised During the Validation

Determinants of Capacity Building	Strategies to Build Human Capacities to Foster Lean Construction	Revised Strategies
Re-worded Strategies to Build Human Capacities		
Individual Level	Lean training	Attend lean training program or train subordinates
	Feedback acceptance and sharing	Accept and share feedback
Industry Level	Conduct cost benefit analysis of lean	Conduct cost benefit analysis of lean implementation and make industry members aware

Determinants of Capacity Building	Strategies to Build Human Capacities to Foster Lean Construction	Revised Strategies
	implementation and aware the industry members	
Government Level	Arrange educational development programs at higher educational level	Arrange lean related program at higher educational level
Merged Strategies to Build Human Capacities		
Organisation Level	Build lean culture Maintain supportive lean culture	Introduce and maintain supportive lean culture
Newly Added Strategies to Build Human Capacities		
Organisation Level		Encourage research on lean implementation

R-V1 recommended to reword two of the individual level strategies namely feedback acceptance and sharing. According to R-V1, *“the proposed strategy is more in a nature of human capacities rather strategies without any action verb at the beginning of each”*. Therefore, R-V1 recommended to change “Feedback acceptance and sharing” as **“Accept and share feedback”**. Moreover, R-V2 highlighted the requirement of rewording another individual level strategy of “lean training”. According to R-V2, *“lean training is more like a human capacity rather a strategy. Moreover, just writing lean training is not implying both the perspectives of train subordinates by top management and attend training programs by subsequent human resource levels”*. Therefore, the proposed strategy of “lean training” was reworded as **“Attend lean training program or train lean to subordinated”**. Further, in order to express the meaning of the industry level strategy of “Conduct cost benefit analysis of lean implementation and aware the industry members”, R-V3 proposed to reword the strategy as **“Conduct cost benefit analysis of lean implementation and make industry members aware”**. Considering the government level strategies, R-V3 suggested to reword the strategy “Arrange educational development programs at higher educational level”. According to R-V3, *“just implementing educational development programs do not reveal the requirement of establishing the lean related programs within higher educational level. Starting from the university level, even the higher educational institutions are necessary to include lean related modules to the students who are studying construction related degree or diploma programs”*. Therefore, the proposed strategy was reworded as **“Arrange lean related program at higher educational level”**.

Further, R-V2 proposed the suitability of merging two strategies stated under the organisation level strategies namely “build lean culture” and “maintain supportive lean culture”. Instead of two different strategies related to lean culture, R-V2 suggested to merge them as one strategy namely **“Introduce and maintain supportive lean**

culture". Further, according to R-V1, one more strategy was added under the organisation level as **"Encourage research on lean implementation"**. More comprehensively R-V1 stated that, *"even the organisation level can also encourage its employees in involving research and development regarding lean construction since more you explore lean, more you get insights on possible implementation strategies on lean construction"*.

According to the validator's comments and recommendations, the research findings were revised and validated. Further, the initially developed research model was revised accordingly as illustrated in Figure 4.5 by incorporating the revised and verified research findings on necessary human capacities to lean implementation and strategies to build human capacities to the large-scale contractors in Sri Lanka.

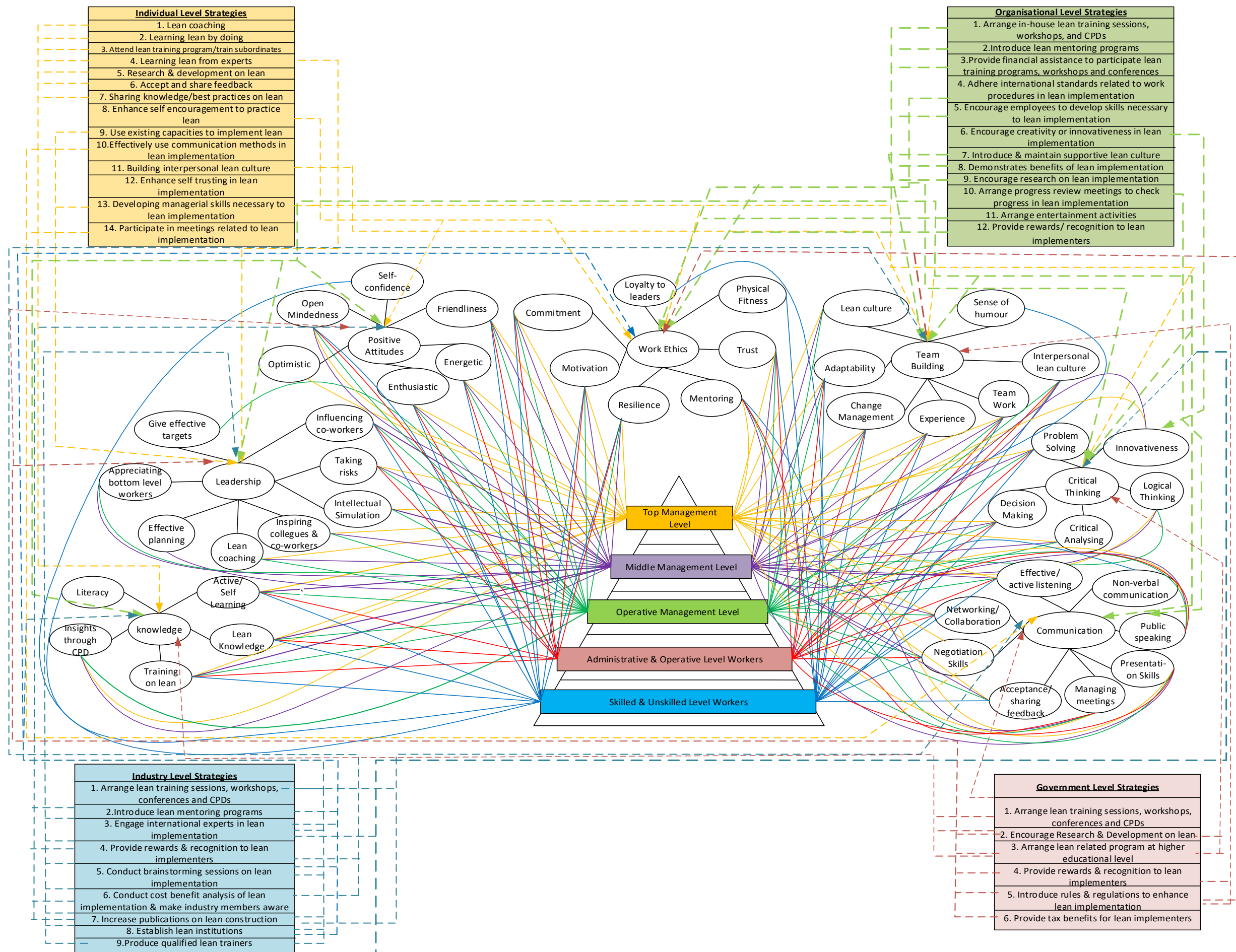


Figure 4.5: Revised Model to Foster Lean Construction Through Human Capacity Building in Large Scale Contactors in Sri Lankan Construction Industry

4.10 Summary

In this chapter, the respondents were questioned regarding human related challenges, human capacities, and strategies to build human capacities for successful lean implementation based on the human resource hierarchical levels of top management employees, middle management employees, operative management employees, administrative and operative level workers and skilled and unskilled level workers. After analysing the human related challenges impacting the successful lean construction implementation in the Sri Lankan context, it was deduced that some common human related challenges are impacting for all the hierarchical levels of human resources in large scale construction projects. Accordingly, lack of leadership skills required in lean implementation, lack of required knowledge levels in implementing lean construction, lack in obtaining training on lean construction related tools, techniques, principles, and the resistance of the workers to change or adopt to the newly developed culture within the organisation were highlighted by the respondents. Further, many of the human related challenges, which were significantly impacting to the human resources at different hierarchical level have been highlighted by the respondents.

Moreover, the experts highlighted the necessary human capacities to foster lean construction in large scale contractors in Sri Lanka. Accordingly, some of the human capacities including knowledge on lean construction, sharing information relevant to lean construction implementation within human resources, communication skills such as networking, collaboration, negotiation, and developing adaptability of human resources have been highlighted in common for each hierarchical level. Further, the significant human capacities necessary for lean implementation for each hierarchical levels employees or workers have also been highlighted. Finally, the advantages that can be achieved by large scale contractors in lean construction implementation in Sri Lankan construction industry were highlighted. Accordingly, the advantages similar in nature were highlighted by the respondents for the three levels of managerial staff. Further, few of the advantages, which were similar in nature for all the hierarchical levels of human resources have also been identified.

Subsequently, the strategies to build human capacities were identified in Phase II research findings under four levels namely individual, organisational, industry, and government level. Finally, in Phase III, the identified strategies and human capacities to be built in lean implementation were validated by proposing the developed research model to three validators. Accordingly, the final research model on fostering lean construction through human capacity building in large scale contractors in Sri Lankan construction industry was developed and presented in this chapter.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter provides an overview and the conclusions derived from the study and describes the contribution to knowledge of this research. This chapter further discusses about the limitations of this study. Finally, recommendations to academic researchers and industry practitioners are provided.

5.2 Overview of the research and conclusions drawn from the study

Through the background study conducted at Chapter 1, significant numbers of construction organisations and industry practitioners are paying attention to bring lean thinking for the successful project delivery. However, with the identification of challenges impacting to successful lean construction implementation, many human related aspects such as lack of training, lack of top management commitment, lack of lean awareness, lack of lean culture, and lack of required capacities in human resources were identified as barriers for lean implementation both in global and Sri Lankan contexts. Further, human capacity building has the key potential towards the successful lean implementation in construction industry. Thus, building human capacity for successful lean implementation has been identified as a paramount research focus in construction industry. Therefore, the aim of this study was identified as to develop a model to foster lean construction through human capacity building by large-scale contractors in construction industry. The research aim, was achieved through the accomplishment of five main objectives of the study.

Objective 1: Review the need of human capacity building for fostering lean in construction industry

This objective was achieved through the in-depth literature synthesis conducted in Chapter 2 of this study, on lean construction implementation and significance of human capacity building in lean implementation. Initially the definitions of lean construction provided in the literature sources were reviewed (sub-section 2.3.1). Considering the definitions provided in literature, LC was defined as “production management-based approach, which employ the lean thinking to the construction process in order to achieve the balanced use of resources while reducing cost, eliminating waste, emphasizing continuous improvement and achieving value maximisation” by the authors. Later, effective human involvement and importance of human capacities for successful lean implementation have been highlighted as significant drivers of lean implementation (Sub-section 2.3.4).

Further, several barriers of lean implementation have also identified including major complications of lean implementation namely workforce, cultural, managerial, and technical related barriers (Sub-section 2.3.5). Subsequently, the possible strategies to overcome the barriers of lean implementation has been reviewed. Accordingly, the importance of the effective involvement of human resources and capacity building have been identified including several strategies such as early deployment of lean culture, enhancement of lean awareness and involvement of employees, higher commitment and the effective participation of management (Sub-section 2.3.6). Therefore, the authors focused on the term “Capacity Building” and identified the definitions provided by literature sources on Human Capacity Building (Section 2.5). Accordingly, the authors have derived a definition for human capacity building as “a process of building knowledge, skills, understanding, thinking ability and expertise of individuals irrespective of gender in order to carry out the functions and achieve the specific objectives efficiently and effectively”.

The authors have identified human related challenges in lean implementation and possible strategies to overcome the aforementioned human related challenges with respect to the human resources hierarchical levels namely top-level management, middle level management, operative level management, administrative and operative level employees and, skilled and unskilled level workers. Accordingly, the study has emphasised the necessity of human capacity building to foster lean construction in global context (Section 2.10). Several capacities such as collaborative management, commitment, knowledge, educational level, training, and learning have been identified as common capacities for two or more hierarchical levels while some capacities, which are unique to each level have also been identified by the authors. Later the possible strategies to build the human capacities have been presented in Section 2.11 under four determinant of capacity building at different levels of individual, organisational, industry, and government.

Objective 2: Investigate human related challenges faced by construction organisations in implementing lean concept in Sri Lankan construction industry

The second objective was accomplished by empirical findings of Phase I. The existing human related challenges of lean implementation in global context, which were identified in the literature synthesis were referred to experts in order to identify the challenges impacting the lean implementation in Sri Lankan context (Section 4.3). Human related challenges of lean implementation were identified with respect to the aforementioned five hierarchical levels. Accordingly, several human related challenges impacting to all hierarchical levels have been emphasised by authors as lack or no commitment to lean implementation, lack of leadership skills, knowledge level constraints, lack of lean training, lack of interest in lean implementation, lack or no motivation, lack of communication, higher work pressure, resistance to change, lack

of networking and collaboration, lack of team work, lack of lean ethics, and human attitudinal issues.

Further, some human related challenges significantly impacting to the managerial level employees have also been stressed in Section 4.3 such as lack of awareness and understanding on lean, lack of knowledge sharing, lack of lean initiation, lack of encouraging bottom level workers, lack of accepting feedback from bottom level workers, and lack of intrinsic motivators. Further, some of the challenges significant to the operative level managers have also been identified in the study such as lack of ability to get work done from others, and lack of ability to engage with bottom level workers. Several challenges such as fear of giving feedback to management levels, illiteracy, lack of interest in self and organisational development, lack of encouragement, and lack of appreciation from management levels have been identified specifically to the skilled and unskilled level workers.

Objective 3: Determine human capacities necessary for fostering lean in Sri Lankan construction industry

Objective 3 was achieved through empirical findings in Phase I. The human capacities necessary for fostering lean in Sri Lankan construction industry were identified with respect to the aforementioned five hierarchical levels of human resources in large scale contractors. The study was narrowed to identify human capacities based on the seven sub capacity categories as proposed by Ranadewa et al. (2021). Under the sub category of knowledge, several human capacities such as lean knowledge, training on lean, and active and self-learning have been identified by the researchers impacting for each hierarchical level. Insights through Continual Professional Development (CPD) was significantly highlighted for the managerial level employees while literacy was specified for the skilled and unskilled level workers. When considering the critical thinking sub category, problem solving and decision making have been identified for each human resources hierarchical level while innovativeness, critical analysing, and logical thinking were identified specifically for the managerial level employees.

The authors have highlighted the necessity of building human capacities under the sub category of positive attitudes in human resources of each hierarchical levels. Accordingly, open mindedness, optimistic, enthusiastic, energetic, and friendliness have been identified as necessary human capacities to each hierarchical level. The majority of human capacities identified with respect to the leadership have been highlighted to the managerial level employees such as taking risks, intellectual simulation, inspiring bottom level workers, effective planning, and lean coaching. In addition to that, human capacity of influencing co-workers has been identified for each hierarchical level. When considering the communication sub category common human capacities have been identified as effective listening, networking and

collaboration, and negotiation. Further, managing meetings, presentation skilled and public speaking have been identified for the managerial level employees and administrative level workers. Majority of the human capacities under team building sub-category was identified for each hierarchical levels such as interpersonal lean culture, adaptability, change management, team work, and experience. Under the sub category of work ethics, trust, commitment, and motivation have been identified for each hierarchical level. Mentoring was specified for the managerial level employees.

Objective 4: Investigate the advantages of building human capacities necessary for fostering lean in Sri Lankan construction industry

This was achieved by the empirical investigation in Phase I. The authors have identified the advantages of building human capacities necessary to foster lean in Sri Lankan construction industry under five hierarchical levels of human resources (Section 4.5). Accordingly, the majority of advantages have been specified to human resources of each hierarchical levels such as creating enthusiastic individuals, increasing self-learning and self-confidence, developing collaboration and creating good feedback loop within human resources of organisation. Moreover, some advantages have been specifically highlighted for the managerial level employees such as enhanced decision-making procedure, ability of smoothly driving changes within working environment, creating well reputed organisation within country, and enhanced critical thinking ability. In addition to that, enhance physical and mental stability of the workers, and increased health and safety conditions of the workers have been highlighted for the skilled and unskilled level workers.

Objective 5: Propose strategies to build human capacities necessary for fostering lean construction in Sri Lankan construction industry

This objective was achieved through the empirical findings in Phase II. The strategies to build human capacities necessary for fostering lean construction in Sri Lankan construction industry were identified with respect to the aforementioned five hierarchical levels of human resources in large scale contractors. Further, the strategies have been identified under the determinants of human capacity building under four levels namely individual, organisational, industry, and government levels. Accordingly, several individual level strategies were emphasised by the authors such as lean coaching, learning lean by doing, learning from lean experts, sharing knowledge or best practices on lean, and enhance self-encouragement to practice lean. When considering the organisational level strategies, the authors have identified several strategies such as introduce lean mentoring programs, arrange in-house lean training sessions, workshops and CPDs, adhere international standards related to work procedures in lean implementation, provide rewards or recognition to lean implementers. According to the authors, industry can also play a vital role in building

human capacities necessary for lean implementation. The proposed strategies under industry level can be highlighted as introduce lean mentoring programs, arrange in house lean training sessions, workshops and CPDs, engage international experts in lean implementation, conduct brainstorming sessions on lean, and produce qualified lean trainers. The government can also take initiatives in building human capacities necessary for lean implementation such as encourage research and development, arrange lean related programs at higher educational level, and provide tax benefits for lean implementers.

Later, the collected data from Phases I and II regarding human capacities necessary to foster lean construction and strategies to build human capacities for successful lean implementation were integrated in to the research model. The developed model was presented to three lean experts for validation. According to the opinions and recommendations received from experts, the proposed strategies under four levels of individual, organisational, industry, and government were reworded, merged, and some strategies were newly added. Several strategies under individual, industry, and government level were re-worded. Moreover, two strategies proposed under organisation level namely build lean culture and maintain supportive lean culture were merged together and developed a new strategy of “Introduce and maintain supportive lean culture”. Additionally, a new strategy was proposed to the organisational level strategies namely “Encourage research on lean implementation”. Later the initially developed research model was refined by incorporating the revised and verified research findings on necessary human capacities to lean implementation and strategies to build human capacities to the large-scale contractors in Sri Lanka.

5.3 Contribution to the knowledge

The present study makes several noteworthy contributions to the existing body of knowledge as follows:

1. Derived a definition for lean construction as *“production management-based approach, which employ the lean thinking to the construction process in order to achieve the balanced use of resources while reducing cost, eliminating waste, emphasizing continuous improvement and achieving value maximisation”*.
2. Derived a definition for human capacity building as a *“process of building knowledge, skills, understanding, thinking ability and expertise of individuals irrespective of gender in order to carry out the functions and achieve the specific objectives efficiently and effectively”*.
3. Drivers and barriers of lean construction implementation in global and Sri Lankan context.

4. Advantages of building human capacities necessary in lean implementation in construction industry
5. Strategies of building human capacities necessary to lean implementation under individual, organisational, industry, and government level in construction industry

5.4 Recommendations for industry practitioners

This study made certain recommendations for the industry practitioners as follows:

1. Understanding the human related challenges of lean implementation and getting prepared for them
2. Understanding the human capacities necessary for lean implementation and initiating to build those capacities
3. Understanding the potential advantages of building human capacities necessary for lean implementation
4. Employing the framework, which was developed by this study to use the strategies to build the human capacities necessary in lean implementation

5.5 Further research directions

The following further research directions were proposed to extend the research further:

1. Extend the research to investigate the organisational capacities necessary in lean implementation in large scale contractors in Sri Lanka
2. Assess the success of proposed research model by implementing the strategies identified within organisation level
3. Explore the difficulties in implementing identified strategies in lean implementation and mechanisms to overcome the difficulties
4. Identify the suitability of proposed lean enabling human capacity building model through a case study analysis of large-scale construction projects

Accordingly, extensive research was conducted to address the research problem on how to foster lean construction through human capacity building in Sri Lankan construction industry. The aim of the research study of develop a model to foster LC through human capacity building by large-scale contractors in construction industry was achieved through identifying human related challenges in lean implementation, human capacities necessary to foster lean construction, advantages of building human capacities in lean implementation, and strategies to build human capacities to foster lean construction in Sri Lankan construction industry.

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List of publications

- Sandagomika, N.M.G.H., Sandanayake, Y.G. (2021), Human Related Challenges in Lean Implementation: A Case of Sri Lankan Large Scale Contractors, *4th European IEOM Conference*, Rome, Italy, <http://ieomsociety.org/proceedings/2021rome/464.pdf>
- Sandagomika, N.M.G.H., Sandanayake, Y.G. (2021), A Model for Human Capacity Building of Large-Scale Contractors to Foster Lean Construction in Sri Lanka, *9th World Construction Symposium (WCS)* 2021, <http://dl.lib.uom.lk/handle/123/16547>
- Sandagomika, N.M.G.H., Sandanayake, Y.G (Under development), How to enable lean through human capacity building in large scale contractors of Sri Lanka, *International Journal of Construction Management*

Appendix A: Summary table for human related challenged of lean construction implementation in Sri Lankan construction industry

Top Management	Middle Management	Operative Level Managers	Administrative and Operative Level Workers	Skilled and Unskilled Level Workers	Common Terminology
Lack of commitment	Lack of commitment	Lack of commitment	No commitment at all	No commitment at all	Lack/ No commitment to lean implementation
Lack of leadership skills	Lack of leadership skills	Lack of leadership skills	Lack of leadership skills	Lack of leadership skills	Lack of leadership skills
Lack of awareness and understanding	Lack of awareness & understanding	Lack of awareness and understanding			Lack of awareness and understanding on lean
Knowledge level constraints	Knowledge level constraints	Knowledge level constraints	Knowledge level constraints	Knowledge level constraints	Lean related Knowledge level constraints
Lack of knowledge sharing	Lack of knowledge sharing	-	-	-	Lack of knowledge sharing
Lack of lean training	Lack of lean training	Lack of lean training	Lack of lean training	Lack of lean training	Lack of lean training
Lack of interest	Lack of interest	Lack of interest	Lack of interest	Lack of interest	Lack of interest in lean concept
Lack of lean initiation	Lack of lean initiation				Lack of lean initiation
Lack of encouraging bottom level workers	Lack of encouraging bottom level workers	Lack of encouraging bottom level workers	-	-	Lack of encouraging bottom level workers
Lack of motivating bottom level workers	Lack of motivating bottom level workers	Lack of motivating bottom level workers	Lack of motivation	No motivation	Lack/ no motivation
Lack of listening	Lack of listening	-	-	-	

Top Management	Middle Management	Operative Level Managers	Administrative and Operative Level Workers	Skilled and Unskilled Level Workers	Common Terminology
Not accepting feedback	Lack of accepting feedback from bottom level workers	-	-	-	Lack of accepting feedback from bottom level workers
-	-	-	-	Fear of giving feedback to management levels	Fear of giving feedback to management levels
Lack of communication	Lack of communication	Lack of communication	Lack of communication	Lack of communication	Lack of communication
Higher work pressure	Higher work pressure	Higher work pressure	Higher work pressure	Higher work pressure	Higher work pressure
Lack of trust					Lack of trust
Resistance to change	Resistance to change	Resistance to change	Resistance to change	Resistance to change	Resistance to change
Attitudes of top management	Attitudes of middle management	Attitudes of operative level management	Attitudes of employees	Attitudes of workers	Human attitudinal issue towards lean implementation
-	-	-	-	Not accepting advices from management levels	
-	Lack of self-learning	-	-	Lack of self-learning/ active learning	Lack of active/ self-learning
-	Lack of networking and collaboration	Lack of networking and collaboration	Lack of networking and collaboration	Lack of networking and collaborationv	Lack of networking and collaboration
-	Unwillingness to take risks	-	-	-	Unwillingness to take risks
-	-	Lack of self-management	Lack of self-management	-	Lack of self-management
-	-	Lack of ability to get work done from bottom levels	-	-	Lack of ability to engage with bottom level workers

Top Management	Middle Management	Operative Level Managers	Administrative and Operative Level Workers	Skilled and Unskilled Level Workers	Common Terminology
-	-	Lack of ability to engage with bottom level workers	-	-	
-	-	-	Taking more time to implementation process	-	Taking more time to lean implementation
-	Lack of team work	Lack of team work	Lack of team work	Lack of teamwork	Lack of teamwork in lean implementation
				Illiteracy	Illiteracy
Lack of lean ethics	Lack of lean ethics	Lack of lean ethics	Lack of lean ethics	Lack of lean ethics	Lack of lean ethics
				Lack of interest in self-development	Lack of interest in self-development
-	-	-	-	Lack of interest in organisational development	Lack of interest in organisational development
-	-	-	-	Lack of encouragement	Lack of encouragement
-	-	-	-	Lack of appreciation from management levels	Lack of appreciation from management levels
-	-	-	-	Lack of curiosity	Lack of curiosity in lean concept and its applications
Lack of intrinsic motivators	Lack of intrinsic motivators	Lack of intrinsic motivators	-	-	

Appendix B: Human capacities necessary for lean construction implementation in Sri Lankan construction industry

Top Management	Middle Management	Operative Level Managers	Administrative & Operative Level Employees	Skilled & Unskilled Level Workers	Common Terminology
Knowledge					
Lean knowledge (Fundamental, core & advanced levels)	Lean knowledge	Lean knowledge	Lean knowledge	Lean knowledge	Lean knowledge
Conducting training	Training on Lean	Training on Lean	Training on Lean	Training on Lean	Training on Lean
Active learning	Active learning	Active learning	Active learning	Active learning	Active / Self-learning
Self-learning	Self-learning	Self-learning	Self-learning	Self-learning	
Insights through CPD	Insights through CPD	Insights through CPD	-	-	Insights through CPD
-	-	-	-	Literacy	Literacy
Critical Thinking					
Problem solving	Problem solving	Problem solving	Problem solving	Problem solving	Problem solving
Decision making	Decision making	Decision making	Decision making	Decision making	Decision making
Innovativeness	Innovating	-	-	-	Innovativeness
Critical analysing	Critical analysing	Critical analysing	-	-	Critical analysing
Logical thinking	Logical thinking	Logical thinking	-	-	Logical thinking
Positive Attitudes					
Open mind set	Open mind set	Open mind set	Open mind set	Open mind set	Open mindedness
Optimistic	Optimistic	Optimistic	Optimistic	Optimistic	Optimistic
Enthusiastic	Enthusiastic	Enthusiastic	Enthusiastic	Enthusiastic	Enthusiastic
Energetic	Energetic	Energetic	Energetic	Energetic	Energetic
Friendliness	Friendliness	Friendliness	Friendliness	Friendliness	Friendliness
-	-	-	-	Self confidence	Self confidence

Top Management	Middle Management	Operative Level Managers	Administrative & Operative Level Employees	Skilled & Unskilled Level Workers	Common Terminology
Leadership					
-	Influencing co-workers	Influencing co-workers	Influencing co-workers	Influencing co-workers	Influencing co-workers
Taking risks	Taking risks	Taking risks	Taking risks		Taking risks
Intellectual stimulation	Intellectual stimulation	Intellectual stimulation	-	-	Intellectual stimulation
Inspiring colleagues & co-workers	Inspiring colleagues & co-workers	Inspiring bottom level workers	-	-	Inspiring colleagues & co-workers
Lean coaching	Lean coaching	Lean coaching	-	-	Lean coaching
-	Appreciating colleagues & co-workers	Appreciating bottom level workers	-	-	Appreciating bottom level workers
-	Effective planning	Effective planning	-	-	Effective planning
-	-	Give effective targets	-	-	Give effective targets
Communication					
Effective listening	Effective listening	Effective listening	Effective listening	Active listening	Effective/ active listening
Networking	Networking	Networking	Networking	Networking	Networking
Collaboration	Collaboration	Collaboration	Collaboration	Collaboration	Collaboration
Negotiation	Negotiation	Negotiation skills	Negotiation skills	Negotiation	Negotiation skills
Accepting and sharing feedback	Accepting and sharing feedback	Timely feedback sharing	-	Actively sharing & accepting feedback	Acceptance/ sharing feedbacks
Managing meetings	Managing meetings	Managing meetings	Managing meetings	-	Managing meetings
Presentation skills	Presentation skills	Presentation skills	Presentation skills	-	Presentation skills
Public speaking	Public speaking	Public speaking	Public speaking	-	Public speaking
-	-	-	-	Non-verbal communication	Non-verbal communication

Top Management	Middle Management	Operative Level Managers	Administrative & Operative Level Employees	Skilled & Unskilled Level Workers	Common Terminology
Team Building					
Interpersonal lean culture	Interpersonal lean culture	Interpersonal lean culture	Interpersonal lean culture	Interpersonal lean culture	Interpersonal lean culture
Adaptability	Adaptability	Adaptability	Adaptability	Adaptability	Adaptability
Change management	Change management	Change management	Change management	Change management	Change management
Lean culture	Lean culture	Lean culture	-	-	Lean culture
Team work	Team work	Team work	Team work	Team work	Team work
Experience	Experience	Experience	Experience	Experience	Experience
-	-	-	-	Sense of humour	Sense of humour
Work Ethics					
Trust	Trust	Trust	Trust	Trust	Trust
Commitment	Commitment	Commitment	Commitment	Commitment	Commitment
Motivating	Motivating	Motivating	Motivation	Motivation	Motivation
	Resilience	Resilience	Resilience	Resilience	Resilience
Mentoring	Mentoring	Mentoring	-	-	Mentoring
-	-	Showing concern	-	-	Showing concern
-	-	-	-	Loyalty to leaders	Loyalty to leaders
-	-	-	-	Physical fitness	Physical fitness

Appendix C: Summary Table for Advantages of Building Human Capacities necessary in Lean Construction Implementation

Top Management	Middle Management	Operative Level Managers	Administrative and Operative Level Workers	Skilled and Unskilled Level Workers	Common Terminology
Creating enthusiastic individuals	Creating enthusiastic individuals	Creating enthusiastic individuals	Creating enthusiastic individuals	Creating enthusiastic individuals	Creating a set of enthusiastic human resources
Reducing stress of individuals due to collaboration	Reducing stress of individuals due to collaboration	Reducing stress of individuals due to collaboration	Reducing stress of individuals due to collaboration	Reducing stress of individuals due to collaboration	Reduced stress of workers due to decreased conflicts within collaborative working environment
Increasing self-learning	Increasing self-learning	Increasing self-learning	Increasing self-learning	Increasing self-learning	Increasing self-learning of individuals
Increasing self-confidence	Increasing self-confidence	Increasing self-confidence	Increasing self-confidence	Increasing self-confidence	Increasing self-confidence of employees
Increasing self-management	Increasing self-management	Increasing self-management	Increasing self-management	Increasing self-management	Increasing self-management of individuals
Creating good feedback loop	Creating good feedback loop	Creating good feedback loop	Creating good feedback loop	Creating good feedback loop	Creating a good feedback loop within human resources of organisation
Developing collaboration	Developing collaboration	Developing collaboration	Developing collaboration	Developing collaboration	Development of more collaborative working environment

Easy to make managerial decisions	Easy to make managerial decisions	Easy to make managerial decisions	-	-	Enhance decision making procedure; easy to make managerial decision
Smoothly driving change in organisation	Smoothly driving change in organisation	Smoothly driving change in organisation	-	-	Ability of smoothly driving change within working environment
Enhancing the organisations' reputation	Enhancing the organisations' reputation	Enhancing the organisations' reputation	-	-	Creating a well reputed organisation within country
Enhance critical thinking ability	Enhance critical thinking ability	Enhance critical thinking ability	-	-	Increased critical thinking ability of management level
-	-	-	Easy to control the individual behaviour	Easy to control the individual behaviour	Easy to control the behaviour of the workers
-	-	-	Decrease the amount of rework within the sub divisions of organisation	-	Decrease the amount of rework within the sub divisions of organisation
-	-	-	-	Enhanced physical and mental stability of workers	Enhanced physical and mental stability of workers
-	-	-	-	Increasing health and safety conditions of workers	Increasing health and safety conditions of workers

Appendix D: Semi structured interview guideline – Phase I

Covering Letter

Sandagomika N.M.G.H.,
Research Scholar,
Department of Building Economics,
University of Moratuwa.

....../....../2021

.....,
.....,
.....,
Dear Sir,

Research Dissertation (M.Sc. by Research) – Data Collection Instrument

I am a postgraduate student of University of Moratuwa, reading for Master of Science (by Research). I am conducting research titled “Fostering Lean Construction through Human Capacity Building; An Empirical Study of the Large-Scale Contractors in Construction Industry”. This research is conducted under the supervision of Prof. Yasangika Sandanayake, Department of Building Economics, University of Moratuwa.

I am conducting interviews for construction projects focussing on construction projects by large contractors, which have employed lean construction concept. Below mentioned objectives are intended to be accomplished through these projects.

1. Investigate human related challenges face by construction organisations in implementing lean concept in Sri Lankan construction industry.
2. Investigate human capacities necessary for the successful lean implementation in Sri Lankan construction industry.

Kindly allow me an appointment to conduct the interviews. The interview would take approximately 45 minutes in this regard. I assure that the information collected will be purely used for the research purpose, whereas the confidentiality of the details provided will be maintained at all times.

Thank You,
Yours Faithfully,

.....
Sandagomika N.M.G.H.
Email: sandagomikanmgh.20@uom.lk | Tel: 071-7489430

Data Collection Instrument

Section I – Details of the Respondent

1. Name (Optional):
2. Designation:
3. Name of the Organization (Optional):
4. Work Experience:
5. Do you have experience in lean implementation in construction projects?
.....

Section II – Human Related Challenges in Lean Implementation

1. In your opinion, what is “Lean Construction”?
.....
2. Do you consider human related challenges as major barriers for successful implementation of lean concept in projects handle by large-scale contractors in Sri Lanka? Provide reasons for your answer.
.....
3. According to your knowledge and experience, what are the human related challenges face by the following categories of people in large scale contractors when implementing lean concept in construction projects in Sri Lanka?

Level	Human Challenges	Related
▪ Managerial Level Staff		
○ Top Level Management		
○ Middle Level Management		
○ Operative Level Management		
▪ Administrative and Operative Level Employees		
▪ Skilled and Unskilled Level Workers		

Section III – Human Capacities Necessary for Lean Implementation

4. Do you think human capacities are necessary for lean implementation in construction industry? Provide reasons for your answer.

.....

5. According to your knowledge and experience, what are the human capacities to be developed by the following categories of people in large scale contractors for successful lean implementation in construction projects in Sri Lanka?

Level	Human Capacities Necessary for Lean Implementation
▪ Managerial Level Staff	
○ Top Level Management	
○ Middle Level Management	
○ Operative Level Management	
▪ Administrative and Operative Level Employees	
▪ Skilled and Unskilled Level Workers	

Section IV – Advantages and Difficulties in Building Human Capacities

6. In your opinion, what are the advantages that can be gained by large scale contractors by building human capacities of the following categories of people that are necessary for lean implementation?

Level	Advantages of Building Human Capacities
▪ Managerial Level Staff	
○ Top Level Management	
○ Middle Level Management	
○ Operative Level Management	
▪ Administrative and Operative Level Employees	
▪ Skilled and Unskilled Level Workers	

- Thank you very much for your contribution -

Annexure (For Interviewer's Reference Only)

Human related challenges identified from literature

	Human Related Challenges
	Managerial Level Staff
	<i>Top Level Management</i>
1	Lack of commitment
2	Lack of leadership skills
3	Lack of awareness
4	Lack of knowledge and experience sharing
5	Lack of interest in implementing new concepts
6	Lack of feeling urgency to change
7	Lack of proper backing support to implement new concepts
8	Lack of proper communication from top management to bottom levels
9	Lack of long-term forecast of lean benefits
	<i>Middle Level Management</i>
10	Lack of committed training
11	Lack of incentives
12	Mis-conceptualisation of lean construction tools
13	Lack of clear definition of roles and responsibilities
14	Delaying in communication (eg: delaying in providing planning information)
	<i>Operative Level Management</i>
15	Lack of incentives
16	Lack of proper communication towards skilled and unskilled workers
17	Lack of clear definition of roles and responsibilities
18	Lack of trust and abilities
19	Difficulty to adapting lean culture
20	Existing the role of traditional authoritative style
	<i>Administrative Level Employees</i>
21	Higher complexity to practice lean in administrative activities
22	Long implementation time
23	Reluctance to engage in an involvement-based leadership
	<i>Skilled and Unskilled Level Workers</i>
24	Lack of proper training
25	Lack of knowledge and understanding
26	Resistance to change in working culture
27	More time consuming to train and make understand workers on lean practices
28	Misconceptions about lean practices
29	Lack of cooperation by workers
30	Lack of teamwork
31	Not giving any rewards besides normal wages
32	Lack of involvement of construction workers
	Any Other Challenges?

Human related capacities identified from literature

	Human Capacities Necessary for Lean Implementation
	<i>Top Level Management</i>
1	Passion and tenacity about lean
2	True understanding
3	Decision making
4	Standard and systematic way of work
5	Effective work allocation
6	Collaborative management
7	Commitment
8	Education level
9	Ability of understanding new concepts
10	Continual professional development
11	Training
12	Learning
13	Sharing knowledge
14	Positive attitudes
15	Patience
16	Consistency
17	Personal Interest
18	Respect
19	Challenge
20	Communication skills
21	Quality of work life
22	Critical thinking
23	Problem solving ability
24	Long term thinking
25	Effective coordination
26	Effective planning
	<i>Middle Level Management</i>
27	Acknowledging and rewarding co-workers
28	Contribution in effort improvement
29	Decision making in the project level
30	Communication skills
31	Executing plans
32	Effective planning for sub-units
33	Interpreting lean practices to lower-level management
34	Inspiring lower-level management
	<i>Operative level management</i>
35	Supervisory skills
36	Upholding harmony
37	Upholding discipline
38	Maintaining communication circles
	<i>Administrative Level Employees</i>
39	Networking/ internal relationship building
40	Ability to get along with others
41	Ability to document and report results to various audiences
42	Ability to synthesize information
	<i>Skilled and Unskilled Workers</i>

43	Enthusiasm and energy
44	Flexibility
45	Creativity
46	Sense of humour
47	Ability to get along with others
48	Patience and perseverance
49	Team building skills
	Any Other Human Capacities?

Advantages that can be gained by large scale contractors by building human capacities necessary for lean implementation (identified from literature)

	Advantages
	<i>Top Management Level</i>
1	Explore and innovate in the use of human resources to provide new thinking to the organisation
2	Enable a firm to adapt to lean and achieve competitive advantage
3	Ability to address the flexible market responses through emerging new thinking to the organisation
4	Ability to capture the maximum possible economic value and value creation
5	Leads to firms' profitability through higher employees performance
6	Strengthen the trust and commitment of management levels
	<i>Middle Management Level</i>
7	Ability of building atmosphere of coordination and peace among lower-level management
8	Improving the communication lines between management levels
9	Strengthen the trust and commitment of management levels
	<i>Operative Management Level</i>
10	Strengthen the trust and commitment of management levels
11	Enhance the confidence level of management regarding the future growth and success through lean practices
	<i>Administrative Level Employees</i>
12	Train for the exact skills that the organisation requires in lean implementation
13	Ability of developing good relationships among top and bottom level employees
	<i>Skilled and Unskilled Workers</i>
14	Workforce would be able to continuously adopt and acquire needed skills for lean implementation
15	Ability to better access talent and increase motivation towards lean implementation
16	Create a win-win environment where workers can better grow and develop towards lean implementation
17	Help workers to move away from routine and let the workers to learn from new approach
	Any Other Advantages?

Appendix E: Interview transcript – Phase I

Covering Letter

Sandagomika N.M.G.H.,
Research Scholar,
Department of Building Economics,
University of Moratuwa.

....../....../2021

.....,
.....,
.....,

Dear Sir,

Research Dissertation (M.Sc. by Research) – Data Collection Instrument

I am a postgraduate student of University of Moratuwa, reading for Master of Science (by Research). I am conducting research titled “Fostering Lean Construction through Human Capacity Building; An Empirical Study of the Large-Scale Contractors in Construction Industry”. This research is conducted under the supervision of Prof. Yasangika Sandanayake, Department of Building Economics, University of Moratuwa.

I am conducting interviews for construction projects focussing on construction projects by large contractors, which have employed lean construction concept. Below mentioned objectives are intended to be accomplished through these projects.

1. Investigate human related challenges face by construction organisations in implementing lean concept in Sri Lankan construction industry.
2. Investigate human capacities necessary for the successful lean implementation in Sri Lankan construction industry.

Kindly allow me an appointment to conduct the interviews. The interview would take approximately 45 minutes in this regard. I assure that the information collected will be purely used for the research purpose, whereas the confidentiality of the details provided will be maintained at all times.

Thank You,
Yours Faithfully,

.....

Sandagomika N.M.G.H.

Email: sandagomikanmgh.20@uom.lk | Tel: 071-7489430

Data Collection Instrument

Section I – Details of the Respondent

1. Name (Optional): *Mr. Madhushka Ekanayake*
2. Designation: *Unit Manager*
3. Name of the Organization (Optional): *International Construction Consortium (Pvt) Ltd*
4. Work Experience: *13 Years*
5. Do you have experience in lean implementation in construction projects? *Yes.*

Section II – Human Related Challenges in Lean Implementation

6. In your opinion, what is “Lean Construction”?

In global context lean concept has been implemented in several types of industries including manufacturing and construction. When consider the production companies, for example manufacturing companies like brandix, this has been precisely implemented with many improvements. But when consider the SL context, the implementation process is very poor.

When consider the lean construction, it can be implemented project wise. The major purpose that can be achieved through lean implementation would be minimizing cost and maximizing productivity. When consider different types of construction, the alterations need to be done are differing from project to project. In lean construction we generally do continuous improvement to the different steps of construction project and ultimately reduce the waste related to each step of construction process.

7. Do you consider human related challenges as major barriers for successful implementation of lean concept in projects handle by large-scale contractors in Sri Lanka? Provide reasons for your answer.

Definitely, the human resources are playing a major role in lean implementation. Generally, the lean implementation needs to be executed from the top to bottom human resources in construction industry. When we consider some old aged companies which are operating for nearly 40 to 50 years, we can see the majority of top management including very old aged professionals. According to them, there are some conventional procedure of project management and execution. The majority of such human resources are not tending to bring new reforms to the construction. With the experience of such professionals, they know that project will be executed with or without these new concepts. The problem is they have no idea what importance will bring these new concepts to the construction project and as well to the organization.

Human resources are quite difficult to control even in lean implementation. But in the organizations which are implementing lean, they are taking many risks in construction procedure.

8. According to your knowledge and experience, what are the human related challenges face by the following categories of people in large scale contractors when implementing lean concept in construction projects in Sri Lanka?

Level	Human Related Challenges
▪ Managerial Level Staff	
○ Top Level Management	<i>Resistance to change is important, no commitment at all and this will be applicable to all the levels of human resources.</i> <i>Work pressure is again a challenge and this will be applicable to all the levels. All the workers and employees in construction industry are under pressure. Therefore, they don't have time to involve in new concepts.</i> <i>Top management are taking strategical decisions. If they make a decision that LPS is necessary to implement, others have to agree and perform accordingly though they do not prefer to. So, another major problem is that top level is not initiating this.</i> <i>Knowledge level constraints is another challenge, either for top or bottom. In most cases top management do have the knowledge but very less portion of top management are also not having required knowledge level for lean implementation.</i> <i>Top management is depending only on middle and operative level management. They do not listen to skilled unskilled workers. But in lean it is necessary to listen to bottom level since they are the workers</i> <i>Lack of trust is another big issue. Resistance to change is a main issue as majority are not interested in getting away from their comfort zone from top to bottom.</i> <i>Lack of training is another challenge from top to bottom, top management even can train the bottom level workers. One more thing is bottom level workers are not listening to the management level employees. Illiteracy is another problem of bottom level workers. Even though the top management</i>

	<i>drive the lean implementation bottom levels cant understand what the top management is saying.</i> <i>Communication gap is another challenge that remain between all the human resources. Due to this gap, majority of the advices or instructions are not properly delivering to bottom level workers. This is a major problem that we are currently facing.</i> <i>Another one is lack of accepting feedbacks. Skilled people are fear in giving feedback while managerial levels are not ready to accept any feedback from bottom level. You have to go to Gemba and see, that is fundamental</i> <i>Another thins is lack of leadership skills, from top to bottom must have leadership skills separately in lean implementation. This need to be addressed. Lack of urgency to change is not necessary in SL context. But if you get this from some other respondent you can add this.</i> <i>Lack of appreciating the workers is another challenge, lack of incentives is not the proper word, you need to appreciate your workers.</i> <i>Lack of motivation is another challenge relevant to all the levels. Under the motivation intrinsic values need to be considered under the top management employees. Again, lack of encouragement is a problem. The combination of motivation, encouragement, and appreciation is necessary for proper lean implementation</i> <i>Attitudes of employees is important for human resources of each hierarchical levels</i>
○ Middle Level Management	<i>Lack of commitment can be seen significantly in the middle level management employees.</i> <i>Lack of accepting feedback from operative management and bottom level workers is a challenge. In communication process, not conveying the messages from middle to top management properly is another challenge.</i> <i>When considering the leadership to this management level, lack in conveying strategical decision is a major challenge as they are the people who are making strategic decisions.</i>

○ Operative Level Management	<i>When considering the leadership, lack of leadership to implement lean with the bottom level workers is another issue. A good leader should know about how to get the work done from the bottom level workers. But not doing everything by the leader themselves.</i>
▪ Administrative and Operative Level Employees	<i>Administrative staff is taking more time to implementing or advising lean to co-workers.</i> <i>Lack of support, lack of encouragement, high work load, resistance to change from the normal workload they are carrying out are some common challenges.</i> <i>They can market the lean implementation in administrative level, but they usually don't. so, it is a challenge. However, as a human resources, their contribution would be considerably less, majorly they can contribute in lean implementation in the perspective of organisation.</i>
▪ Skilled and Unskilled Level Workers	<i>At first, they must be able to perform what they are instructed, that is the most important thing. So, the challenge is they are not doing what they are instructed with.</i> <i>Again, they don't have any knowledge on lean including non-value adding activities, lean tools, principles, techniques etc. so this directly connects with their illiteracy. Majority of the skilled and unskilled labourers are illiterate; therefore, a big issue occurs from their end in lean implementation.</i> <i>They don't have any motivation or commitment in lean implementation. They just come to the work do whatever they have to do and just leave on time. Irrespective of that, they don't have any intention of learning anything. So, lack of active learning and self-learning is another challenge of this category. In lean you have to do self-learning.</i> <i>Even these workers do not have any desire of self-development, and also organisational development. Also, they don't have any curiosity to learn new things.</i>

Section III – Human Capacities Necessary for Lean Implementation

9. Do you think human capacities are necessary for lean implementation in construction industry? Provide reasons for your answer.

Definitely, it is important as human are the drivers of lean implementation, not the organization, not the government, or not the industry. So individuals must know the importance of human capacity building.

10. According to your knowledge and experience, what are the human capacities to be developed by the following categories of people in large scale contractors for successful lean implementation in construction projects in Sri Lanka?

Level	Human Capacities Necessary for Lean Implementation
▪ Managerial Level Staff	
○ Top Level Management	<i>Proper ethics, human attitudes, Leadership, proper communication, active learning, self-learning, team work is important as a whole</i> <i>Ability to critically analyse and think logically is important to top level. They also must have the open mind set to implement lean.</i> <i>Again, knowledge is important for each level, as I believe to successfully implement lean, each level need to have a knowledge on lean concept, lean principals, and lean tools. Bottom level can't implement without the consent and advice from top level, even the top-level cant implement without the help and commitment of bottom level. So, there must be a vice versa connection. When consider tools, they also have different levels of knowledge requirement. Just think of LPS. In their top management must have an idea of whole including how to draw value stream map etc. But operational management do not require knowledge with such extent, they might be involving in just one part of implementation. So, the level of knowledge required from level to level is different.</i> <i>Lean culture is again important, but this is not just the organisational culture as it is not the human capacity. So this should be something like interpersonal lean culture, which the individual must build lean culture within them selves</i> <i>Lean coaching is again important for each managerial level, when they learn something new, they must teach those to the others.</i> <i>Participating in CPD is aging important for managerial level workers.</i>
○ Middle Level Management	<i>Majority of the capacities that I stated above are relevant to this level as well</i>
○ Operative Level Management	<i>Proper two-way communication is important. Giving feedback properly for the bottom level workers is important. As well taking the feedback from bottom level workers is also important in lean implementation.</i>
▪ Administrative and Operative Level Employees	<i>Majority has stated above as whole. Networking and collaboration is important for this level, even for all the levels.</i>

▪ Skilled and Unskilled Level Workers	<i>Active learning, passive learning, sense of humour is again important but for the team building, not directly to the lean implementation</i>
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Section IV – Advantages and Difficulties in Building Human Capacities

11. In your opinion, what are the advantages that can be gained by large scale contractors by building human capacities of the following categories of people that are necessary for lean implementation?

The major benefit is they will be able to implement lean, in that case the top management to bottom level workers, they all will be benefitting,

Level	Advantages of Building Human Capacities
▪ Managerial Level Staff	<i>When considering the managerial levels, many strategical benefits can be achieved like reducing the cost of the project, reducing time using, can have more collaborative workers, any change can be smoothly drive, decision making ability and critical thinking ability can be increased.</i>
○ Top Level Management	<i>Specifically, the organisation as a whole, a well reputed organisation can be built. In Sri Lanka, lean is still in infancy stage. If you can develop these capacities and implement lean successfully, you are going to be recognised by the others. They are going to be identified as lean trainers,</i>
○ Middle Level Management	<i>They can go for promotions rather top-level management</i>
○ Operative Level Management	<i>They can go for promotions rather top-level management</i>
▪ Administrative and Operative Level Employees	
▪ Skilled and Unskilled Level Workers	

So as a whole of each human resource level, the opportunity cost can be reduced due to the human capacity building. When considering each level, set of enthusiastic employees can be identified within organisation, so the way of working would be easier. Nature of self-learning would be increased, when they are learning something, people will be highly motivated and so the active learning nature will also be increased. Majority of people are fear of accepting challenging of general nature, but when we build their motivation, people will be able to accept any challenge, this again highlights the motivation of the employees. Again, a good feedback loop will be generated within all the human resources. Another important thing is when they are getting trained, their capacities are improving and so they can make a high demand from other projects in other recruitments.

- Thank you very much for your contribution –

Appendix F: Semi structured interview guideline – Phase II

Covering Letter

Sandagomika N.M.G.H.,
Research Scholar,
Department of Building Economics,
University of Moratuwa.
....../....../2021

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.....,

Dear Sir,

Research Dissertation (M.Sc. by Research) – Data Collection Instrument (PHASE II)

I am a postgraduate student of University of Moratuwa, reading for Master of Science (by Research). I am conducting research titled “Fostering Lean Construction through Human Capacity Building; An Empirical Study of the Large-Scale Contractors in Construction Industry”. This research is conducted under the supervision of Prof. Yasangika Sandanayake, Department of Building Economics, University of Moratuwa.

I am conducting the expert interviews focussing on lean construction implementation in large scale contractors of Sri Lanka. I am currently executing the second phase of my data collection process, which is an extension of first phase. During Phase 1 of data collection, I have identified the human related challenges and human capacities necessary for lean implementation, and advantages that can be achieved through human capacity building in lean implementation. Proposing strategies to build human capacities necessary for fostering lean in large scale contractors of Sri Lanka is the intended objective to be achieved in this phase. Kindly allow me an appointment to conduct the interviews. The interview would take approximately 45 minutes. The medium of collecting data will be note taking and audio recording (with the permission of interviewee) in order to collect data more accurately. I assure that the information collected will be purely used for the research purpose, whereas the confidentiality of the details provided will be maintained at all times.

Thank You,
Yours Faithfully,

.....

Sandagomika N.M.G.H.

Email: sandagomikanmgh.20@uom.lk | Tel: 071-7489430

Data Collection Instrument

Section I – Details of the Respondent

1. Name (Optional):
2. Designation:
3. Name of the Organization (Optional):
4. Work Experience:
5. Years of delivering expertise in construction projects/ organisations/
academia:

Section II – Strategies to Build Human Capacities Necessary for Lean Implementation

According to your knowledge and experience, what are the strategies that can be proposed to build the human capacities, which are necessary to implement lean by large scale contractors in Sri Lanka? Please provide strategies to be taken by “Individuals”, “Organisations”, “Industry”, and the “Government” in order to build each capacity to foster lean implementation in Sri Lankan construction industry.

(Please refer Annexure 1 which summarized the findings of Phase I, i.e., the human capacities that are necessary to implement lean concept successfully, in proposing strategies).

Human Capacities	Strategies to Build Human Capacities Necessary for Lean Implementation			
	Individual Level	Organisational Level	Industry Level	Government Level
Managerial Level Staff				
Top Level Management				
Knowledge				
Critical thinking				
Positive attitudes				
Leadership				
Communication				
Team building				
Work ethics				
Middle Level Management				
Knowledge				

Human Capacities	Strategies to Build Human Capacities Necessary for Lean Implementation			
	Individual Level	Organisational Level	Industry Level	Government Level
Critical thinking				
Positive attitudes				
Leadership				
Communication				
Team building				
Work ethics				
Operative Level Management				
Knowledge				
Critical thinking				
Positive attitudes				
Leadership				
Communication				
Team building				
Work ethics				
Administrative & Operative Level Employees				
Knowledge				
Critical thinking				
Positive attitudes				
Leadership				
Communication				
Team building				
Work ethics				
Skilled & Unskilled Level Workers				
Knowledge				
Critical thinking				
Positive attitudes				
Leadership				
Communication				
Team building				
Work ethics				

- Thank you very much for your contribution –

Annexure 1 – Human Capacities Necessary for Lean Implementation

Main Categories of Human Capacities	Human Capacities of Different Categories of People				
	Top Level Management	Middle Level Management	Operative Level Management	Administrative & Operative Level Employees	Skilled & Unskilled Level Workers
Knowledge	• Lean knowledge • Conducting training • Insights through CPD • Active/Self-learning	• Lean knowledge • Training on lean • Insights through CPD • Active/Self-learning • Information sharing	• Lean knowledge • Training on lean • Insights through CPD • Active/Self-learning • Information sharing	• Lean knowledge • Training on lean • Active/Self-learning • Information sharing	• Lean knowledge • Training on lean • Active/Self-learning • Information sharing • Literacy
Critical thinking	• Innovativeness • Critical analysis • Logical thinking • Problem solving • Decision making	• Innovativeness • Critical analysis • Logical thinking • Problem solving • Decision making	• Problem solving • Decision making • Logical thinking	• Problem solving • Decision making • Logical thinking	• Problem solving • Logical thinking
Positive attitudes	• Open mindedness • Optimistic	• Open mindedness • Optimistic • Enthusiastic • Energetic	• Open mindedness • Optimistic • Enthusiastic • Energetic • Friendliness	• Open mindedness • Optimistic • Friendliness • Enthusiastic • Energetic	• Open mindedness • Optimistic • Friendliness • Enthusiastic • Energetic • Self confidence • Sense of humour
Leadership	• Intellectual stimulation • Inspiring colleagues & workers • Lean coaching • Taking risks	• Intellectual stimulation • Inspiring colleagues & workers • Appreciating bottom level workers	• Intellectual stimulation • Inspiring colleagues & workers • Appreciating bottom level workers	• Influencing co-workers • Taking risks	• Influencing co-workers

Main Categories of Human Capacities	Human Capacities of Different Categories of People				
	Top Level Management	Middle Level Management	Operative Level Management	Administrative & Operative Level Employees	Skilled & Unskilled Level Workers
		• Influencing co-workers • Lean coaching • Taking risks • Effective planning	• Influencing co-workers • Lean coaching • Taking risks • Effective planning • Give effective target		
Communication	• Effective listening • Networking • Collaboration • Managing meetings • Negotiations • Presentation skills • Public speaking • Acceptance/sharing feedback	• Effective listening • Networking • Collaboration • Managing meetings • Negotiations • Presentation skills • Public speaking • Acceptance/sharing feedback	• Networking • Collaboration • Managing meetings • Negotiations • Presentation skills • Public speaking • Acceptance/sharing feedback	• Effective listening • Networking • Collaboration • Managing meetings • Negotiations • Presentation skills • Public speaking	• Active listening • Networking • Collaboration • Negotiations • Sharing & Accepting feedback • Non-verbal communication
Team building	• Interpersonal lean culture • Developing adaptability • Change management • Building lean culture	• Interpersonal lean culture • Developing adaptability • Change management • Experience • Building lean culture	• Interpersonal lean culture • Developing adaptability • Change management • Building lean culture • Team work	• Interpersonal lean culture • Developing adaptability • Change management • Experience • Team work	• Interpersonal lean culture • Developing adaptability • Change management • Experience • Team work
Work ethics	• Trust • Commitment • Motivation	• Trust • Commitment • Motivation	• Trust • Commitment • Motivation	• Trust • Motivation • Resilience	• Trust • Motivation • Resilience

Main Categories of Human Capacities	Human Capacities of Different Categories of People				
	Top Level Management	Middle Level Management	Operative Level Management	Administrative & Operative Level Employees	Skilled & Unskilled Level Workers
	• Mentoring	• Mentoring • Resilience	• Mentoring • Resilience • Showing concern • Proper ethical behaviour	• Proper ethical behaviour	• Loyalty to leaders • Physical fitness

Annexure 2 (For Interviewer's Reference Only)

Strategies to build human capacities identified from literature

Individual Level	Organisational Level	Industry Level	Government Level
Continues urge on learning lean concepts (lean learning)	Support individuals to obtain required lean knowledge	Enhance collaborative practices among parties in the construction industry	Introduce new laws and regulations to support lean implementation
Individual commitment on training lean practices	Promote training and learning within organisation	Encourage academic industry partnerships in lean research	Establish stable economic and political environment within the country
Develop self-confidence and commitment	Encourage mentoring and enhance individual awareness on lean benefits	Build the innovative models for individuals and organisations	Provide tax concessions for lean implemented projects
Enhance the individual knowledge through self-learning process	Improve the organisational capacities to respond to present and future	Develop new collaborative procurement, partnering and integrated project delivery forms	Provide loan facilities at concessional interest rates
Enhance the self-awareness of lean practices throughout processes	Persuade individuals in partnerships to work with others	Conduct seminars and workshops on lean construction	
Improving individual morale by themselves	Promote new developments within an organisation	Publish research on lean construction by construction industry authorities	
Self-development of soft skills	Adopt lean culture within the organisations	Organise lean conference by relevant authorities and institutions	
	Plan and organise individual tasks effectively within the organisation	Produce lean trainers by lean institute	
	Have a rewards scheme to motivate the lean implementors		

Appendix G: Interview transcript – Phase II

Covering Letter

Sandagomika N.M.G.H.,
Research Scholar,
Department of Building Economics,
University of Moratuwa.
....../....../2021

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.....,

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Thank You,
Yours Faithfully,

.....

Sandagomika N.M.G.H.

Email: sandagomikanmgh.20@uom.lk | Tel: 071-7489430

Data Collection Instrument

Section I – Details of the Respondent

1. Name (Optional): *Dr. T. Ranadewa*
2. Designation: *Senior Lecturer, University of Moratuwa*
3. Name of the Organization (Optional):
4. Work Experience: *13 years*
5. Years of delivering expertise in construction projects/ organisations/ academia: *13 years*

Section II – Strategies to Build Human Capacities Necessary for Lean Implementation

According to your knowledge and experience, what are the strategies that can be proposed to build the human capacities, which are necessary to implement lean by large scale contractors in Sri Lanka? Please provide strategies to be taken by “Individuals”, “Organisations”, “Industry”, and the “Government” in order to build each capacity to foster lean implementation in Sri Lankan construction industry.

(Please refer Annexure 1 which summarized the findings of Phase I, i.e., the human capacities that are necessary to implement lean concept successfully, in proposing strategies).

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Positive attitudes				
Leadership				
Communication				
Team building				
Work ethics				
Middle Level Management				
Knowledge				

Human Capacities	Strategies to Build Human Capacities Necessary for Lean Implementation			
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Positive attitudes				
Leadership				
Communication				
Team building				
Work ethics				
Operative Level Management				
Knowledge				
Critical thinking				
Positive attitudes				
Leadership				
Communication				
Team building				
Work ethics				
Administrative & Operative Level Employees				
Knowledge				
Critical thinking				
Positive attitudes				
Leadership				
Communication				
Team building				
Work ethics				
Skilled & Unskilled Level Workers				
Knowledge				
Critical thinking				
Positive attitudes				
Leadership				
Communication				
Team building				
Work ethics				

Organizing workshops with the help of professional trainers need to addressed for each sub human capacity category. This can be either done in organizational level and industry or government level.

Knowledge

Individuals must try to enhance their knowledge. Therefore, they can participate training workshops. Lean coaching is important, so they need to teach the other on what they have learn. Learning by doing is important, whatever they have learned, they need to implement those. At lease they need to try implementing what they have learned on lean.

Organizations must arrange workshops, training for top levels within the organizational boundaries. Further, the organizations must financially support the top

level to participate in any conferences, or workshops that have been organized external to the organization.

Considering the industry level, they can arrange training programs for concessional rates, therefore, majority would be participating for such knowledge sharing sessions. This can be done by organizations such as CIDA. Also, the international experts can be engaged as resources persons in workshops for the construction industry practitioners. The industry specific resources persons can be specifically hired by the industry, organizations can't do this alone while government focus would be in the whole industries, not specific to the construction.

In the government level, they can provide concessional rates. Financial supporting would be highly considerable in the perspective in industry and government levels. Government can provide tax reductions for lean implementers. So the top management would be inspired and motivated to engage in lean implementation. They also provide training programs. Further government can allocate resources to the industry to support lean implementation.

Critical thinking

Decision making can be shaped by action, so initially they need to take decisions to practice. Learning by doing is important. Feedbacks need to be accepted by other levels.

Organizations can arrange training programs to develop critical thinking. Etiquette training programs can be organized for the top management

Both industry and government need to recognize, give a value in the means of monetary and reward to encourage them.

Positive Attitudes

Individuals must accept feedbacks. The other thing is team work. So, the positive attitude can be shaped, specifically, the top management is difficult to shape the positive attitudes. There are some trainers to enhance positive attitudes and individuals can participate to those. Always the monitoring and reporting is significant. You need to monitor the work process to enhance the positive attitudes. Sharing lean knowledge and best practices with others even within organization and industry level, this will support in continuous improvement. This will also improve the positive attitudes.

Maintaining a lean culture within the organization can be consider under the organizational level. In lean culture, a supportive culture can be experienced. There must be a no blame culture, so the people would be encouraged and motivated to perform, thereby enhance the positive attitudes.

Communication

Training programs can be organized on how to use gestures and postures, this can be done in organization level. Visual communication is also very important. Good communication channels must be there for effective communication and this can be done in organizational level.

Leadership

Leadership camps can be organized in the organizational level, further as a leader lean coaching can be done, thereby you will be sharing what you know with the others. So the knowledge level of others will also improve. Start lean by doing is again important for leadership. Another thing is lean skill development relevant to the leadership.

Again, using existing capacities can be enhance the leadership. Existing capacities in the sense, rather than going for new human resources in lean implementation, you can hire existing resources as lean leader within the organization.

Team building

Both government and industry must support in building above capacities. Specially in the means of research and development. Specifically, the research grants need to be allocated for the industry practitioners and financial support needs to be given for the organizations and individuals.

Work ethics

Recognition is very important from the government level. When we consider CIDA, awarding ceremonies can be organized to give recognition. For mentoring, there need to be mentoring experts. So, these experts can be trained by the government. To enhance trust, learning can be identified as a strategy. Because if you confident enough, you can trust yourself.

- Thank you very much for your contribution -

