

**LEAN ENABLING CAPACITY BUILDING
FRAMEWORK FOR SMALL AND MEDIUM
ENTERPRISES IN CONSTRUCTION INDUSTRY**

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Degree of Doctor of Philosophy

Department of Building Economics

University of Moratuwa

Sri Lanka

August 2021

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Thesis submitted in partial fulfilment of the requirements for the degree of
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DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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ABSTRACT

Lean Enabling Capacity Building Framework for Small and Medium Enterprises in Construction Industry

Lean implementation has embarked on a positive trend in Small and Medium Enterprises (SMEs) in the construction industry. Lean practices ensure yielding a higher value for construction processes at a lower cost. However, countless barriers have led to a low success rate in lean implementation in construction SMEs. Therefore, all necessary capacities need to be identified and developed by construction SMEs to achieve the full benefits of lean. Although the challenges of lean implementation in construction and solutions to overcome them have been previously explored in the international arena, there is a dearth of research on lean implementation and strategies to overcome barriers in lean implementation in Sri Lankan context. While exacerbating the situation, capacity building to overcome lean implementation barriers is often overlooked in construction SMEs. Hence, this research aims to develop a lean enabling capacity building framework for construction SMEs in Sri Lanka. The critical review of literature initially developed a working definition for the term construction SMEs in Sri Lanka and established the importance of developing the ability of individual, organisational and environmental capacities to enable lean in order to optimise the value of construction SMEs. The research adopted ontological, idealist assumptions in the interpretive paradigm for the study to collect, analyse and validate data. The data collection comprised of two rounds of empirical investigations (EIR-1 and EIR-2). Adopting a case study strategy, EIR-1 included data collection from five construction SMEs selected through quota sampling. Data triangulation was achieved through 18 semi-structured interviews, three focus group interviews, observations at eleven progress review meetings and eight site visits and documentary reviews. EIR-2 included in-depth interviews with 24 experts selected through purposive sampling.

Findings of EIR-1 were extended to develop a SWOT analysis and 5-Whys analysis to identify non-value adding activities (NVAA) in construction SMEs. EIR-1 further presented the current level of implementation and understanding of lean tools and techniques within construction SMEs. EIR-2 identified 66 drivers and 62 barriers for lean implementation in construction SMEs at three capacity levels. Further, 7, 5 and 4 numbers of lean enabling capacities at individual, organisational and environmental levels of construction SMEs were identified, respectively. 'Lean knowledge dissemination', 'lean learning', 'start lean by doing' and 'lean skills developments' are noteworthy individual level lean enabling strategies. All eleven organisational strategies are interconnected and inter-dependent. 'Maintaining a lean culture', 'networking' and 'lean training' are the foremost organisational lean enabling capacity building strategies out of eleven strategies. All four environmental strategies including 'establishing a professional institute for lean construction', 'organising lean awareness programmes', 'disseminating inter/intra industry lean knowledge' and 'introducing national policies and legislation to support lean implementation' are notable lean enabling capacity building strategies. Lean enabling capacity building framework was developed by mapping the lean enabling capacity building strategies for construction SMEs. This research contributes to the body of knowledge as it uncovers individual, organisational and environmental level strategies for enabling lean through capacity building in Sri Lankan construction SMEs. The outcomes of this research study will be beneficial to construction SMEs, academics, researchers, and government institutions in developing countries sharing similar socio-economic, demographic or cultural traits to Sri Lanka.

Keywords: Capacity Building; Construction Industry; Lean Construction; Small and Medium Enterprises (SMEs); Sri Lanka.

DEDICATION

To all my teachers

&

To my beloved family

ACKNOWLEDGEMENTS

This thesis is accomplished to be indebted much dedication and admiration of many people who have contributed in numerous ways. I express my gratitude to each and every individual for their encouragement, values and ideas, assistance and specially their commitment towards my journey to make success.

First and foremost, I pay gratitude to my dynamic and inspirational supervisors, Prof. Yasangika Sandanayake from University of Moratuwa and Dr. Mohan Siriwardena from Liverpool John Moores University, United Kingdom, for all the guidance, assistance and continuous encouragement provided for the study. I am also indebted to them for their constructive criticisms and most importantly for their extraordinary patience that significantly contributed towards the successful completion of the study. Further, I appreciate the comments and guidance received from the progress review specialists, Prof. Udayangani Kulatunga and Prof. Wathsala Wickramasinghe.

I must express my sincere gratefulness to Mr. Gayan Tudawe, Prof. Ranjith Dissanayake, Mr. Duleesha Wijesiri, Mr. Rohana Illukkumbura, Mr. Saman Mahawatta, Dr. Rohan Karunarathna and Mr. Madura Wijewickrama for providing access to the selected cases and experts in the industry. Further, I must forward gratitude to all the participants in the data collection process for their time, collaboration, openness and support in making my study a success.

Further, I highly appreciate the invaluable comments and feedback received from Prof. Lauri Koskela, Dr. Tommelein Iris, Dr. Glenn Ballard, Mr. Alan Mossman and Dr. Tariq Abdelhamid to making me realise what constitutes of '*Lean construction*' during the IGLC 2018 conference.

I would like to thank Mr. Darshana Rathnayake and Mr. Sumedha from MAS Holdings; Mr. Aruna and Mr. Mahesh from Karcher - Sri Lanka for the irreplaceable support in collecting data. Further, a special thank goes to Dr. Dinesh Samarasinghe and Dr. I. Mahakalanda of the University of Moratuwa for their advices given for the data analysis. I extended my gratitude to Dr. Chethana Illankoon, University of

Newcastle, Australia for her invaluable help and support, which had a highly positive influence on my journey.

Especially, I am very much grateful to all former and present Research Coordinators of the Department, Heads of the Department, Director Postgraduate Studies – Faculty of Architecture and Dean of the Faculty for their assistance and guidance during my studentship. Further, I would like to thank all my colleagues in the Department of Building Economics for their friendship, and assistance in numerous ways. Besides, I appreciate the technical support received from Mr. Rajah and Mr. Udayashantha.

I am forever indebted to my beloved father and mother, who went through so many hardships to get me to where I am now. Without them, I would not be here. I also express my deepest gratitude to all members in Ranadewa and Jayawardena families for their unconditional love, emotional sacrifices, and their constant help and encouragement.

I owe a special thanks to my little boy Yuthmina Jayawardena for bringing real happiness to my life and continuously tolerating all the hard times created with my demanding schedules. Finally, I am so grateful, with much respect to my loving husband Kirana Jayawardena for his continued support, patience, encouragement to make this study success and for his caring, sacrificing his valuable time and his commitment to my achievements.

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LIST OF ABBREVIATIONS

3P	- Production Preparation Process
5-Whys	- Five-Whys Analysis
BIM	- Building Information Modelling
BOQ	- Bills of Quantities
CBA	- Choosing By Advantage
CAD	- Canadian Dollar
CCI	- Chamber of Construction Industry Sri Lanka
CIDA	- Construction Industry Development Authority
CIOB	- Ceylon Institute of Builders
COYLE	- Chamber of Young Lanka Entrepreneurs
CPD	- Continuous Professional Development
EIR	- Empirical Investigation Round
ERP	- Enterprise Resource Planning
GDP	- Gross Domestic Product
H&S	- Health and Safety
HRM	- Human Resource Management
IFC	- International Finance Corporation
IGLC	- International Group for Lean Construction
IPD	- Integrated Project Delivery
JIT	- Just-in-Time
KTP	- Knowledge Transfer Partnerships
LBMS	- Location Based Management System
LKR	- Sri Lankan Rupees
LPS	- Last Planner System
MR	- Malaysian Ringgit
MENA	- Middle East and North Africa
NCASL	- National Construction Association of Sri Lanka
NVAA	- Non-Value Adding Activities
OECD	- Organisation for Economic Co-operation and Development
PAQS	- Pacific Association of Quantity Surveyors

PDCA	- Plan-Do-Check-Act
PEPFAR	- President's Emergency Plan for AIDS Relief
QSR	- Qualitative Solutions and Research Limited
R&D	- Research and Development
RCA	- Root Cause Analysis
RPS	- Reverse Phase Scheduling
SME	- Small and Medium Enterprises
SMED	- Single Minute Exchange of Dies
TFV	- Transformation-Flow-Value
TPM	- Total Productive Maintenance
TPS	- Toyota Production System
TQM	- Total Quality Management
TVD	- Target-Value Design
UNDP	- United Nations Development Programme
UNESCO	- United Nations Educational, Scientific and Cultural Organisation
USD	- United States Dollar
VAA	- Value Adding Activities
VSM	- Value Stream Mapping