A RESPONSIBLE TECHNOLOGICAL TRANSFORMATION FRAMEWORK FOR MICROMOBILITY MANUFACTURING INDUSTRY IN SRI LANKA

W.A.D.C. Iresha

248039F

Master of Science (Major Component Research)

Department of Transport Management & Logistics Engineering

Engineering Faculty

University of Moratuwa

Sri Lanka

January 2026

A RESPONSIBLE TECHNOLOGICAL TRANSFORMATION FRAMEWORK FOR MICROMOBILITY MANUFACTURING INDUSTRY IN SRI LANKA

W.A.D.C. Iresha

248039F

Thesis/Dissertation submitted in partial fulfillment of the requirements for the degree Master of Science (Major Component Research)

Department of Transport Management & Logistics Engineering

Faculty of Engineering

University of Moratuwa

Sri Lanka

January 2026

DECLARATION

I declare that this is my own work and this thesis/dissertation 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. I retain the right to use this content in whole or part in future works (such as articles or books).

Signature: Date:30.01.2026

The above candidate has carried out research for the Master's thesis under my supervision. I confirm that the declaration made above by the student is true and correct.

Name of Supervisor: Prof. H.N. Perera

Signature of the Supervisor: Date:30.01.2026

ACKNOWLEDGEMENT

I would like to express my sincere appreciation to all those who contributed in many ways to the successful completion of this research study.

Foremost, I wish to convey my deepest gratitude to my supervisor, Prof. Niles Perera, Professor in Supply Chain Management, Department of Transport Management & Logistics Engineering, Faculty of Engineering, University of Moratuwa for his continuous guidance, encouragement, and immense support throughout this research. His valuable insights, thoughtful direction, and patient mentorship played a pivotal role in shaping the direction and outcomes of this study. I am privileged to have conducted this research under his supervision.

I gratefully acknowledge the financial support provided by the Industry Sponsored Research Studentship of Faculty of Graduate Studies - Sponsored by The Institute of Management UK - Sri Lanka. I also gratefully acknowledge the University of Moratuwa Senate Research Committee (SRC/ST/2024/25) and the Norwegian Program for Capacity Development in Higher Education and Research for Development (NORHED II – Project No. 68085).

I wish to express my sincere appreciation to all the examiners of the progress review for their valuable insights and guidance, which significantly contributed to the successful completion of my research study. My special thanks go to Prof. Amila Thibbotuwawa and Dr. Ranil Sugathadasa. I would also like to extend my sincere gratitude to the external advisor, Dr. Deepesh Jayasekara, Institute for Manufacturing, Department of Engineering, University of Cambridge, United Kingdom, for his valuable guidance and expert insights, which enriched this research.

I gratefully acknowledge the valuable contributions of experts and organizations within the micromobility industry in Sri Lanka, whose cooperation was essential to the research data collection process. I sincerely thank industry practitioners and stakeholders for generously sharing their time, expertise, and operational insights, as well as for providing access to relevant data and information. Their practical perspectives were instrumental in grounding this research in real-world industrial contexts.

I am also thankful to the Head of the Department and the academic and non-academic staff of the Department of Transport Management and Logistics Engineering for their continued support.

My heartfelt gratitude is extended to my family for their unwavering encouragement, understanding, and sacrifices. Their constant support has been a source of strength throughout my academic pursuits and personal challenges, and this achievement would not have been possible without them.

Finally, I would like to warmly acknowledge my colleagues at the Center for Supply Chain Operations and Logistics Optimization (SCOLO) for their continuous motivation, collaboration, and support, which enriched this research journey.

Abstract

The manufacturing sector is experiencing rapid technological disruption driven by Industry 4.0 and the transition toward Industry 5.0. While these advancements promise efficiency and innovation, they also raise critical concerns regarding ethics, sustainability, and workforce displacement. This study examines Responsible Technological Transformation (RTT) as a framework for balancing technological adoption with social, environmental, and organizational considerations. Drawing on Dynamic Capability Theory, Socio-Technical Theory, and Resource Dependence Theory, the research develops and empirically tests a model linking Human–Machine Collaboration (HMC) and Human-Centered Artificial Intelligence (HCAI) to Technology Readiness at both technical (TRL) and organizational (OTRL) levels, with RTT mediating their effects on supply chain capabilities and manufacturing performance. A survey of two hundred respondents from Sri Lanka's micro-mobility manufacturing sector was analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). Sri Lanka serves as a representative case of developing economies navigating responsible transformation, offering insights for other emerging manufacturing contexts. Unlike prior studies focused narrowly on Responsible AI or Industry 4.0/5.0, this research integrates HMC, HCAI, TRL/OTRL, and RTT into a unified pathway, uncovering how responsible transformation translates human-centered technologies into resilience, agility, and firm performance. Results reveal that HMC and HCAI significantly enhance both TRL and OTRL, with organizational readiness exerting a stronger influence. RTT emerges as a critical enabler of Supply Chain Resilience (SCR) and Supply Chain Agility (SCA), which in turn positively impact Manufacturing Firm Performance (MFP). The study concludes that sustainable competitiveness in manufacturing depends on embedding responsibility alongside technological adoption.

Keywords: Supply Chain Resilience, Supply Chain Agility, Responsible Technological Transformation, Human Machine Collaboration, Human Centered Artificial Intelligence

TABLE OF CONTENTS

Declaration i
Acknowledgement ii
Abstract iii
Table of Contents iv
List of Figures vi
List of Tables vii
List of Abbreviations viii
List of Appendices ix
CHAPTER 1 – INTRODUCTION 1
1.1. Background of Study 1
1.2. Research Gap and Research Questions 2
CHAPTER 2 – LITERATURE REVIEW 3
2.1. Human-Machine Collaboration 3
2.2. Human-Centered Artificial Intelligence 3
2.3. Responsible Technology Transformation 3
2.4. Technology Readiness 4
2.5. Supply Chain Resilience 4
2.6. Supply Chain Agility 5
2.7. Manufacturing Firm Performance 5
CHAPTER 3 - THEORETICAL BACKGROUND AND HYPOTHESES DEVELOPMENT 7
3.1. Theoretical Background 7
3.1.1. Dynamic Capability Theory 7
3.1.2. Sociotechnical Theory 7
3.1.3. Resource Dependence Theory 8
3.2. Hypotheses Development 8
3.2.1. The Impact of Human-Machine Collaboration and Human-Centered Artificial Intelligence on Technology Readiness. 8
3.2.2. The Impact of Technology Readiness on Responsible Technological Transformation 9

3.2.3. The Impact of Responsible Technological Transformation on Supply Chain Resilience and Agility. 9
3.2.4. The Impact of Supply Chain Resilience and Agility on Manufacturing Firm's Performance 10
CHAPTER 4 – RESEARCH METHODOLOGY 12
4.1. Questionnaire Design 14
4.2. Sampling & Data Collection 15
4.3. Common Method Bias 16
CHAPTER 5 – DATA ANALYSIS AND RESULTS 18
5.1. Assessment of Measurement Model 18
5.2. Assessment of Structural Model 20
CHAPTER 6 – DISCUSSION 23
6.1. Theoretical Implications 24
6.2. Practical Implication 25
CHAPTER 7 – CONCLUSION 27
7.1. Research Limitations 27
7.2. Future Research Directions 27
8. REFERENCES 29
APPENDICES 39

LIST OF FIGURES

Figure **Description** **Page**

Figure 1- Theoretical Framework 10
Figure 2- Hypothesis & Conceptual Model in PLS-SEM Framework 14
Figure 3- Micromobility Supply Chain-Sri Lanka..... 16
Figure 4- Final structural model output in SmartPLS. 24
Figure 5- Summarized final structural model output. 26

LIST OF TABLES

Table **Description** **Page**

Table 1-Sample composition 17
Table 2-Reliability Validity 18
Table 3-Fornell Larcker Criterion 19
Table 4-Heterotrait–Monotrait ratio 19
Table 5–Significance of direct effect in the Structural Model 21
Table 6-Significance of Indirect Effect in the Structural Model 21

LIST OF ABBREVIATIONS

Abbreviation	Description
AI	Artificial Intelligence
AVE	Average Variance Extracted
CB-SEM	Co-variance based Structural Equation Modeling
CMB	Common Method Bias
DCT	Dynamic Capability Theory
HAIC	Human Artificial Intelligence Collaboration
HMC	Human Machine Collaboration
MFP	Manufacturing Firm's Performance
OTRL	Organizational Technological Readiness Level
PLS-SEM	Partial Least Squares Structural Equation Modeling
RBT	Resource Based Theory
RDT	Resource Dependence Theory
RTT	Responsible Technological Transformation
SCA	Supply Chain Agility
SCD	Supply Chain Digitalization
SCR	Supply Chain Resilience
SEM	Structural Equation Modeling
ST	Sociotechnical Theory
TRL	Technological Readiness Level
VIF	Variance Inflation Factor
VSC	Viable Supply Chain

LIST OF APPENDICES

Appendix **Description** **Page**

Appendix 1- Survey Questionnaire 39
Appendix 2- Measurement Scale 40