

**FROM WASTE TO RESILIENCE: POLICY
DEVELOPMENT FOR DIGITAL TRANSFORMATION
OF AGRI-FOOD SUPPLY CHAINS IN DEVELOPING
ECONOMIES**

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Doctor of Philosophy

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Thesis/Dissertation submitted in partial fulfillment of the requirements for the degree
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DECLARATION

As per the cotutelle agreement between the University of Moratuwa, Sri Lanka, and the University of Stavanger, Norway, this thesis has been prepared and submitted under a joint supervision arrangement. This cotutelle agreement was approved under Council Memo No: 509.05.07 at the 509th Council Meeting held on 3rd May 2023.

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

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The above candidate has carried out research for the PhD/~~MPhil/Masters~~ thesis/dissertation under my supervision. I confirm that the declaration made above by the student is true and correct.

Name of Supervisor: H. Niles Perera

Signature of the Supervisor:

Date: 02/01/2026

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ABSTRACT

Agri-food supply chains in developing economies play a critical role in food security and farmer livelihoods, yet they remain fragmented, inefficient, and highly vulnerable to disruptions. As a result, they are often unable to meet dynamic demand patterns, increasing risks to food security and farmer livelihoods. Due to these characteristics, these supply chains are referred to as traditional agri-food supply chains because they tend to be more labour-intensive and fragmented. These systemic inefficiencies not only undermine resilience and sustainability but also limit equitable benefit distribution among smallholder farmers and consumers. Therefore, this doctoral research explores how digital transformation can be leveraged as a policy-driven strategy to modernise agri-food supply chains, enhance resilience, and strengthen food security in developing economies. This study adopts the traditional vegetable supply chain in Sri Lanka as the primary case study. The adopted methodology is case study oriented, emphasising practical implementation and real-world impact. The research study comprises three main phases as problem identification, a comparison between the “current state” and “future state” for policy integration, and solution formulation. This resulted in the following: 1) systematic identification of waste drivers and circular economy-based mitigation strategies; 2) a fuzzy inference system-based risk assessment framework aligned with ISO 31000:2018; 3) a performance measurement framework for data-scarce environments using price volatility as a proxy, introducing the Agri-Food Volatility Balanced Scorecard; and 4) a conceptual digital governance model to regulate and coordinate agri-food supply chains in developing economies. The findings demonstrate how digital transformation, when aligned with regulatory oversight and evidence-based policy design, can significantly reduce waste, stabilise prices, and improve coordination among stakeholders. Ultimately, this research provides actionable insights and policy pathways for transitioning traditional agri-food supply chains in developing economies into sustainable, resilient, and digitally enabled systems, thereby safeguarding food security and improving farmer livelihoods in developing economies.

Keywords: agri-food supply chains, digital transformation, policy, resilience, waste, developing economies

TABLE OF CONTENTS

Declaration	i
Acknowledgement.....	ii
Abstract	iii
Table of Contents	iv
List of Figures	vi
List of Tables.....	viii
List of Abbreviations.....	ix
CHAPTER 1	1
INTRODUCTION	1
1.1. Background of the Study	1
1.2. Motivation for the Study	2
1.3. Thesis Structure	3
CHAPTER 2	4
LITERATURE REVIEW.....	4
2.1. Theoretical Background	4
2.1.1. Digital Transformation.....	4
2.1.2. Sustainability and Circular Economy.....	5
2.1.3. Supply Chain Resilience	5
2.1.4. Supply Chain Performance and Evaluation	6
2.1.5. Theoretical Integration	6
2.2. Problem Description.....	7
2.2.1. Challenges and Issues in Developing Economy Agri-Food Supply Chains	7
2.2.2. Research Gaps	7
2.2.3. Research Questions	8
2.2.4. Research Objectives	9
CHAPTER 3	10
METHODOLOGY	10
3.1. Overall Research Design	10

3.2. Research Framework	11
3.3. Case Study	12
3.4. Data Collection Methods	13
CHAPTER 4	14
RESULTS AND DISCUSSION	14
4.1. Phase 01- Problem Identification	14
4.1.1. Research Objective 1	14
4.1.2. Study 01 - Research Design	15
4.1.3. Study 02 - Research Design	19
4.2. Phase 02- Comparison between the “Current state” and “Future state”	23
4.2.1. Research Objective 2	23
4.2.2. Study 03 - Research Design	24
4.2.3. Research Objective 3	34
4.2.4. Study 04 - Research Design	35
4.3. Phase 03- Solution Formation	44
4.3.1. Research Objective 4	44
4.3.2. Study 05 - Research Design	45
CHAPTER 5	53
CONCLUSION	53
5.1. Research Contribution	53
5.2. Research Limitations	54
5.3. Future Research Directions	54
References	55

LIST OF FIGURES

Figure	Description	Page
Figure 2.1.	Challenges and Consequences of Agri-food Supply Chains	7
Figure 3.1.	Research Onion Model	10
Figure 3.2.	Research Strategy adopted from Braa & Vidgen, (1999)	10
Figure 3.3.	Overall Research Design	11
Figure 3.4.	Case Study Overview	12
Figure 4.1.	Research Design - Study 1	15
Figure 4.2.	Structural Self-interaction Matrix	16
Figure 4.3.	Final Reachability Matrix	16
Figure 4.4.	MICMAC Analysis	17
Figure 4.5.	ISM Digraph	18
Figure 4.6.	Research Design- Study 2	19
Figure 4.7.	AHP Hierarchy Model	20
Figure 4.8.	Alternative Ranking	22
Figure 4.9.	Supply Chain Flows of AFSCs and CE Strategies	23
Figure 4.10.	Research Design - Study 3	25
Figure 4.11.	Fuzzy Inference System	27
Figure 4.12.	Membership function of PoF	29
Figure 4.13.	Membership functions of CoFs	29
Figure 4.14.	Membership function of PFR	29
Figure 4.15.	Rule Structure	30
Figure 4.16.	3D Surface Plot of each CoF	30
Figure 4.17.	Scenario 1 - Simulated PFR value for Farmer Revenue Loss	31
Figure 4.18.	Scenario Analysis Summary	32
Figure 4.19.	Research Design - Study 4	35
Figure 4.20.	Preliminary Study	35
Figure 4.21.	Outlier Test	36
Figure 4.22.	Price Volatility of the Representative Product	37

Figure 4.23.	AFV-BSC Dimensions and Performance Indicators	37
Figure 4.24.	Agri-food Supply Chain Policy Intervention Strategies	39
Figure 4.25.	Price Gap Ratio and ADPGR Value	41
Figure 4.26.	Cross-Correlation Function Plots for each Tier across Three Scenarios	41
Figure 4.27.	Monthly Average Prices Vs NCPI Values and NSI Value for each Scenario	42
Figure 4.28.	PVSI Value for each Scenario	43
Figure 4.29.	CPI Value for each Scenario	43
Figure 4.30.	Research Design- Study 5	45
Figure 4.31.	Cross-functional Flow Process Mapping Diagram Notations	46
Figure 4.32.	As-Is State Process Map	47
Figure 4.33.	Social Network Diagram	49
Figure 4.34.	Proposed Digitalisation Architecture	50
Figure 4.35.	Comparison of As-Is and To-Be states	52
Figure 5.1.	Overall Study Framework	53

LIST OF TABLES

Table	Description	Page
Table 4.1.	Summary of the AHP Results	20
Table 4.2.	CoF Criteria and Ranges	26
Table 4.3.	Risk Levels	26
Table 4.4.	Risk Matrix	27
Table 4.5.	Gaussian Parameters for Input and Output Variables	28
Table 4.6.	Proposed Mitigation Strategies for CoF in Each Scenario	32
Table 4.7.	Descriptive Statistics	37
Table 4.8.	Presumed Price Variations at each Stage of the Supply Chain	40
Table 4.9.	Summary of Price Transmission Efficiency Values	42
Table 4.10.	Network Metrics for Stakeholders in Case Study AFSC	48

LIST OF ABBREVIATIONS

Abbreviation	Description
AFSC	Agri-food Supply Chains
FL	Food Loss
CE	Circular Economy
AHP	Analytical Hierarchy Process
ISM	Interpretive Structural Modelling
FIS	Fuzzy Inference Systems
DEC	Dedicated Economic Centers
SSIM	Structural Self-interaction Matrix
IRM	Initial Reachability Matrix
FRM	Final Reachability Matrix
PoF	Probability of Failures
CoF	Consequences of Failures
PFR	Potential Failure Risks
HT	Harvest Time
LT	Lead Time
MRT	Market Replenish Time
SCDS	Supply Chain Disruption Scenario
AFV-BSC	Agri-Food Volatility Balanced Scorecard
BSC	Balanced Scorecard
NCPI	National Consumer Price Index
ADPGR	Average Daily Price Gap Ratio
PTE	Price Transmission Efficiency
NSI	Normalized Stability Index
PVSI	Price Volatility Smoothing Index
CPI	Compound Performance Index
SNA	Social Network Analysis
GAPI	Government Agriculture Policy Institute
AIRA	Agriculture Input Regulatory Authority
FAIS	Farming Input Suppliers

AS	Authorized Sellers
AFO	Agriculture Field Officer
FS	Farmer Societies
DCW	Distribution Centre Wholesalers
DCM	Distribution Centre Manager