

**SUPPLY CHAIN QUALITY MANAGEMENT 4.0 FOR SUSTAINABLE
PERFORMANCE EXCELLENCE IN FMCG COMPANIES**

by

QUANG LE TRONG BANG

DISSERTATION

Presented to the Swiss School of Business and Management Geneva
In Partial Fulfillment
Of the Requirements
For the Degree

DOCTOR OF BUSINESS ADMINISTRATION

SWISS SCHOOL OF BUSINESS AND MANAGEMENT GENEVA

FEBRUARY 2026

**SUPPLY CHAIN QUALITY MANAGEMENT 4.0 FOR SUSTAINABLE
PERFORMANCE EXCELLENCE IN FMCG COMPANIES**

by

QUANG LE TRONG BANG

APPROVED BY

A. Buljubasic

Chair

RECEIVED/APPROVED BY:

Renee Goldstein Osmic

SSBM Representative

DEDICATION

This research, titled “Supply Chain Quality Management 4.0 for Sustainable Performance Excellence in FMCG Companies” is dedicated to the key sources of strength and inspiration that have supported me throughout this academic journey.

First and foremost, I would like to express my deepest gratitude to my academic mentors and researchers whose invaluable guidance, knowledge, and intellectual contributions have laid the theoretical foundation for this study. Their insightful direction, constructive feedback, and unwavering commitment to academic rigor have significantly shaped the development and quality of this research. Their mentorship has not only enhanced my understanding of supply chain management, quality management, and Industry 4.0, but also strengthened my critical thinking and research capabilities.

My heartfelt appreciation is extended to my family for their unconditional love, patience, and continuous encouragement. Their belief in my abilities and their constant emotional support have been a profound source of resilience and perseverance during challenging moments. Without their sacrifices and understanding, this research would not have been possible.

Finally, this work is devoted to the inner motivation and determination that have driven me to pursue academic excellence and meaningful contributions to sustainable supply chain development. This enduring sense of purpose has inspired me to remain committed, disciplined, and passionate throughout the entire research process, ultimately shaping the completion of this study.

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my university for providing a supportive academic environment and the necessary resources that enabled the successful completion of this research on “Supply Chain Quality Management 4.0 for Sustainable Performance Excellence in FMCG Companies”. The institution’s commitment to research excellence and interdisciplinary learning has played a vital role in shaping both the direction and quality of this study.

My deepest appreciation is extended to my academic advisor for their invaluable guidance, insightful comments, and continuous encouragement throughout the research process. Their expertise in supply chain management and research methodology significantly contributed to the rigor, coherence, and academic relevance of this work. Their constructive feedback at every stage helped refine the conceptual framework and strengthen the analytical approach adopted in this study.

I am also grateful to my colleagues and peers for their collaborative spirit, thoughtful discussions, and moral support. Their perspectives and suggestions enriched my understanding of practical supply chain challenges, particularly in the context of digital transformation and sustainability within the FMCG sector.

Finally, I would like to acknowledge the organizations and respondents who generously provided the data necessary for this research. Their willingness to share valuable information and insights made the empirical analysis possible and greatly enhanced the reliability and practical relevance of the study’s findings.

ABSTRACT

Title: Supply Chain Quality Management 4.0 for Sustainable Performance Excellence in
FMCG Companies

Author: Quang Le Trong Bang

Advisor: Prof. Dr. Saša Petar, Ph.D

The rapid advancement of digital transformation, coupled with escalating sustainability pressures, has compelled the Fast-Moving Consumer Goods (FMCG) industry to fundamentally reconfigure its operational and quality management paradigms. While Industry 4.0 technologies promise enhanced transparency, integration, and efficiency, empirical evidence remains limited regarding how digitalization can be effectively integrated with supply chain quality management to drive sustainable performance, particularly in emerging market contexts. Addressing this research gap, the present study develops and empirically validates a comprehensive Supply Chain Quality Management 4.0 (SCQM4.0) framework and examines its impact on sustainable supply chain performance within the FMCG sector in Vietnam.

Grounded in the Resource-Based View, Systems Theory, and the Technology–Organization–Environment framework, SCQM4.0 is conceptualized as a multidimensional integrative capability encompassing internal quality management practices, external supply chain integration, quality information systems, and sustainability-oriented quality

management strategies, all reinforced by Industry 4.0 technology adoption. This conceptualization reflects the premise that sustainable performance is achieved not through isolated quality initiatives but through coordinated alignment of organizational processes, inter-firm collaboration, and digital enablement across the supply chain. A quantitative research design was employed, utilizing survey data from 250 managers and professionals across systematically selected FMCG enterprises. The proposed model was assessed using Structural Equation Modeling (SEM), including rigorous measurement validation and structural analysis to test the hypothesized relationships.

The empirical findings demonstrate that SCQM4.0 practices exert a significant and positive influence on sustainable development performance across economic, environmental, and social dimensions, underscoring the strategic importance of quality-driven supply chain coordination. Among the core dimensions, supply chain integration emerges as the most influential driver, highlighting the critical role of collaborative alignment and information sharing among supply chain partners in achieving sustainability objectives. Moreover, the results reveal a nuanced moderating role of Industry 4.0 Technology Adoption (ITA). Although digital technologies theoretically function as enabling mechanisms that enhance coordination, traceability, and real-time quality control, the observed negative moderating effect indicates that current technological implementation in the Vietnamese FMCG context primarily acts as a compensatory mechanism for managerial and integration deficiencies rather than as a fully synergistic catalyst. This outcome is partly attributable to the uneven maturity of digital

transformation, where advanced technologies such as Blockchain and IoT remain underutilized relative to established digital platforms.

By offering a validated multidimensional measurement framework for SCQM4.0 and clarifying the contingent and context-dependent role of Industry 4.0 technologies in shaping sustainability outcomes, this study contributes to both theoretical advancement and managerial practice. The findings refine the conceptual understanding of digitally enabled quality management capabilities in emerging economies and provide actionable insights for FMCG firms seeking to strategically align quality management initiatives with digital transformation efforts to achieve resilient, transparent, and long-term sustainable supply chain performance.

Keywords: SCQM 4.0, Industry 4.0, Sustainability, FMCG, Vietnam, Supply Chain Integration.

TABLE OF CONTENTS

List of Tables	6
List of Figures	8
CHAPTER I: INTRODUCTION.....	9
1.1 Introduction.....	9
1.2 Research Problem	11
1.3 Purpose of Research.....	13
1.4 Significance of the Study	16
1.5 Research Questions	17
1.6 Summary	17
CHAPTER II: REVIEW OF LITERATURE	19
2.1 Theoretical Framework.....	19
2.1.1 Resource-based View – RBV – and the VRIO Framework	19
2.1.2 System theory.....	21
2.1.3 Technology-Organization-Environment framework	23
2.2 Logistics.....	24
2.3 Quality Management Practices (QM)	27
2.4 Supply Chain Quality Management (SCQM).....	29
2.4 I4.0 technologies in SCQM.....	38
2.5. Operational Excellence in Sustainable Supply Chains Performance.....	47
2.6. Sustainable Supply Chain Quality Management (SSCQM):	50
2.7. Conclusion	52
CHAPTER 3: METHODOLOGY	53
3.1 Overview of the Research Problem	53
3.2 Operationalization of Theoretical Constructs	56
3.3 Research Design:	66
3.4 Expert Interview:	73
3.5 Population and Sample:	75

3.6 Data Collection Procedures.....	76
3.7 Data Analysis	76
3.8 Conclusion	79
CHAPTER IV: RESULTS.....	80
4.1 Expert Interview and complete measurement scale:.....	82
4.2 Impact Assessment.....	83
4.3 Moderation Analysis of Industrial 4.0 Technology Adoption	108
4.4 Summary of Findings.....	123
4.5 Conclusion	126
CHAPTER V: DISCUSSION.....	128
5.1 The first Research Question – Develop research scale	128
5.2 The second Research Question – Assessing the impact of SCQM on SDP:	131
5.3 The third Research Question – Assessing the moderating role of Industrial 4.0 Technology Adoption on the impact between SCQM and SDP:.....	138
5.4 Conclusion	139
CHAPTER VI: SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS.....	141
6.1 Summary	141
6.2 Implications.....	141
6.3 Recommendations for Future Research	142
6.5 Conclusion	143
REFERENCE	145

LIST OF TABLES

Table 2. 1 Summarizes key SCQM studies	33
Table 2. 2 Blockchain supply chain research.....	40
Table 2. 3 Main IoT-based solutions and frameworks for the SCQM4.0.....	42
Table 2. 4 Main traceability research trends and findings in SCQM4.0.....	44
Table 2. 5 Summary of smart packaging literature.....	46
Table 4. 1 Overall Expert Interview Results.....	82
Table 4. 2 Name and coding data for Supply Chain Quality Management Practices.....	84
Table 4. 3 Name and coding data for Sustainability Supply Chain Development and Industriad 4.0 Technology Application	86
Table 4. 4 1 st EFA Result	88
Table 4. 5 2nd EFA Result.....	88
Table 4. 6 3rd EFA Result	89
Table 4. 7 Grouped and re-named SCQMs.....	89
Table 4. 8 R-Square result of all SEM Model	95
Table 4. 9 Construct Reliability and Validity of 1st Model.....	96
Table 4. 10 1st Model's Discriminant Validity	96
Table 4. 11 1st Model's F-Square result.....	97
Table 4. 12 1st Model's Bootstrapping Result.....	97
Table 4. 13 Construct Reliability and Validity of 2nd Model	98
Table 4. 14 2nd Model's Discriminant Validity	98
Table 4. 15 1st Model's F-Square result.....	99
Table 4. 16 2nd Model's Bootstrapping Result	99
Table 4. 17 Construct Reliability and Validity of 3rd Model	100
Table 4. 18 3rd Model's Discriminant Validity.....	100
Table 4. 19 3rd Model's F-Square result	101
Table 4. 20 3rd Model's Bootstrapping Result.....	101
Table 4. 21 Construct Reliability and Validity of 4th Model	102
Table 4. 22 4th Model's Discriminant Validity	102

Table 4. 23 4th Model's F-Square result	103
Table 4. 24 4th Model's Bootstrapping Result	103
Table 4. 25 Construct Reliability and Validity of 5th Model	104
Table 4. 26 5th Model's Discriminant Validity	104
Table 4. 27 5th Model's F-Square result	105
Table 4. 28 5th Model's Bootstrapping Result	105
Table 4. 29 Total Path Coefficients in 1st and 2nd Research Question.....	107
Table 4. 30 R Square of 5 Research Model with Moderator effect of ITA	108
Table 4. 31 Construct Reliability and Validity of 1st Model.....	110
Table 4. 32 1st Model's F-Square result	111
Table 4. 33 1st Model's Bootstrapping Result.....	112
Table 4. 34 Construct Reliability and Validity of 2nd Model	114
Table 4. 35 2nd Model's F-Square result.....	115
Table 4. 36 Construct Reliability and Validity of 3rd Model	116
Table 4. 37 3rd Model's F-Square result	117
Table 4. 38 3rd Model's Bootstrapping Result	118
Table 4. 39 Construct Reliability and Validity of 4th Model	120
Table 4. 40 4th Model's F-Square result	121
Table 4. 41 Construct Reliability and Validity of 5th Model	122
Table 4. 42 5th Model's F-Square result	123
Table 4. 43 Impact of each SCQM 4.0 factor group on SDP	125
Table 4. 44 Bootstrapping and Moderator Effect of ITA to relationship between SCQM and SDP	126

LIST OF FIGURES

Figure 2. 1 Framework of Sustainable Supply Chain Quality Management	51
Figure 3. 1 Research model for 1st and 2nd RQ.....	64
Figure 3. 2 Research Model for the 3rd RQ.....	65
Figure 4. 1 Research process by 3 steps	81
Figure 4. 2 The 1st SEM Model.....	93
Figure 4. 3 The 2nd SEM Model	93
Figure 4. 4 The 3rd SEM Model	94
Figure 4. 5 The 4th SEM Model	94
Figure 4. 6 The 5th SEM Model	95
Figure 4. 7 The 1st Model with Moderator effect of ITA 4.0.....	109
Figure 4. 8 The 2nd Model with Moderator effect of ITA 4.0	113
Figure 4. 9 The 3rd Model with Moderator effect of ITA 4.0	115
Figure 4. 10 The 4th Model with Moderator effect of ITA 4.0	119
Figure 4. 11 The 5th Model with Moderator effect of ITA 4.0	121

CHAPTER I: INTRODUCTION

1.1 Introduction

While Supply Chain Management (SCM) has become a dominant theme in contemporary business research, its integration with Quality Management (QM) remains largely disjointed. Despite the acknowledged significance of QM, (Robinson & Malhotra, 2005a) argue that a more rigorous and integrated perspective is required to evaluate quality issues across both internal and external supply chain boundaries. Given the volatility of the modern global market, establishing robust quality practices within multi-echelon supply chains has become an essential strategy for managing the complexities of product and service excellence.

Supply Chain Quality Management (SCQM) represents a holistic paradigm that merges the core tenets of supply chain and quality management. As a strategic framework, it fosters synergistic partnerships between suppliers and end-users to elevate the quality standards of both products and services (Ford, 2015). While traditional quality management often centers on internal operational efficiency (Ross, 2017), SCQM adopts a broader strategic lens. This approach enables organizations to pre-emptively manage quality across the entire network from upstream procurement to downstream distribution (Bastas & Liyanage, 2018a). The transition from isolated business units to a collaborative culture enhances inter-organizational coordination, ultimately driving superior customer satisfaction and process refinement (Robinson & Malhotra, 2005a; Soares et al., 2017).

The emergence of Industry 4.0 (I4.0), first introduced at the Hannover Industrial Fair in Germany in 2011, marked a significant moment in the evolution of technology and

its impact on various sectors (Z. Xu et al., 2021). The fourth industrial revolution introduces a series of new technologies that combine knowledge in the physical, digital and biological domains, impacting many sectors, industries and economies. Nine key technologies identified by the Boston Consulting Group have come into focus: Big Data Analytics (BDA), Autonomous Robots, Simulation, Horizontal and Vertical System Integration, Internet of Things (IoT), Cybersecurity, Cloud Computing, Additive Manufacturing (AM) and Augmented/Virtual Reality (AR/VR) (A. Akbari & Rahimi, 2025). Disruptive I4.0 technologies are indispensable to improve supply chain quality management. I4.0 technologies enable data analytics, process automation, supply chain optimization, and seamless system integration. For example, IoT facilitates real-time monitoring, cybersecurity protects data, cloud computing manages information, AM supports prototyping, and AR enriches training (A. Akbari & Rahimi, 2025; Hofmann & Rüsch, 2017), which highlights the transformative effects of I4.0 technologies on firm performance in supply chain quality management.

(L. T. C. Bui et al., 2025) proposed the integration of Industry 4.0 with SCQM towards an efficient, productive and quality supply chain (SC). Several studies have revolved around the integration of Industry 4.0 with Quality Management (QM) and Supply Chain Management (SCM) (Barata et al., 2018; L. T. C. Bui et al., 2025) to assess the impact of Industry 4.0 on Supply Chain Management (SCQM), paving the way for a knowledge base of research topics and coordination issues to highlight the prospect of deeper connection with SCQM activities. Several benefits of integrating Industry 4.0 into

SCQM have been identified, including cost reduction, improved SC performance and enhanced customer satisfaction (Frederico et al., 2019, 2020).

On the other hand, there is a growing body of research on the integration of supply chain management and Industry 4.0 technologies, showing evidence of improved supply chain performance of enterprises thanks to Industry 4.0 technologies (Fatorachian & Kazemi, 2021; Frederico et al., 2019; Schmidt et al., 2023). Similarly, there is a growing body of research showing evidence of improved quality management thanks to innovations in the manufacturing sector driven by Industry 4.0 technologies (Antony et al., 2022; Sharma et al., 2025). However, there is still a lack of empirical research on the synthesis of Industry 4.0 technologies, supply chain management and quality, as well as its impact on sustainable supply chain performance of enterprises. Several studies have developed conceptual frameworks that incorporate I4.0 technologies such as Blockchain technology (Zheng et al., 2021) and established a new framework for the application of SCQM4.0 (L. T. C. Bui et al., 2025). However, scholars have highlighted concerns about the use of I4.0 technologies in supply chain quality management (SCQM) to adapt to the new digital business era, which requires immediate attention.

1.2 Research Problem

Fast-Moving Consumer Goods (FMCG) refer to affordable, high-turnover products with limited lifespans, encompassing categories such as food, pharmaceuticals, and personal care items. These non-durable goods are characterized by rapid consumption rates and high market demand, typically resulting in large-scale sales volumes. In this sector, pricing strategies and brand equity are pivotal factors in shaping consumer behavior. From

a logistical perspective, the FMCG industry faces significant complexity due to the necessity of managing diverse product portfolios and stringent delivery schedules. Achieving operational excellence requires balancing high-volume distribution with strict quality compliance and cost-effectiveness throughout the supply chain.

The global economic downturn has rendered the FMCG landscape in emerging markets increasingly volatile, uncertain, complex, and ambiguous (VUCA). The Vietnamese market, in particular, suffered a systemic supply chain failure during the COVID-19 pandemic, leading to widespread corporate insolvencies as firms struggled to align supply with shifting market demands. To ensure institutional survival, FMCG entities must now pivot toward meeting heightened consumer expectations for product customization, ecological sustainability, and cost-efficiency. In this context, Industry 4.0 (I4.0) has emerged as a transformative solution, leveraging digital advancements to bolster the competitiveness, resilience, and long-term sustainability of the manufacturing sector.

This paper is a significant contribution to the field of supply chain quality management, with a particular focus on the transformational impact of Industry 4.0 (I4.0) technologies in the context of the FMCG industry in Vietnam. Firstly, in an era where I4.0 technologies have revolutionized many industries, this study addresses a significant research gap by providing a comprehensive examination of the integration of I4.0 technologies, supply chain management, and quality management in the specific context of the FMCG industry. The introduction of a theoretical framework, called Supply Chain Quality Management 4.0 (SCQM4.0), represents a comprehensive approach to effectively

address the complexities and opportunities arising from this integration, especially in the context of developing economies.

Second, this study pursues an empirical investigation into the impact of SCQM4.0 practices on a firm's sustainable supply chain performance, with a specific focus on optimizing productivity, delivering high-quality products and services, and conserving valuable resources throughout the production process. Based on the fundamentals of dynamic capability theory, systems theory, and the technology, organization, and environment (TOE) framework, this study provides a comprehensive theoretical framework that underpins the study. Furthermore, the empirical analysis, based on a dataset collected by the author from 250 Vietnamese FMCG companies, has provided invaluable insights and evidence on the diverse contributions of SCQM4.0 to enhancing sustainable supply chain performance in the fast-moving consumer goods industry. This study not only enriches the theoretical context but also provides practical insights for both the academic and business communities, shedding light on the potential synergies between I4.0 technologies, supply chain management and quality management, as well as their profound impacts on sustainability.

1.3 Purpose of Research

The level of application of Industry 4.0 in the supply chain of Vietnam's FMCG

In an era of increasingly fierce competition, the FMCG industry requires businesses to quickly increase their competitiveness in production. Industry 4.0 has modeled the aspects that must be present in an efficient production system that must respond to rapid changes in technology; industrial production systems; models and social processes (T. Bui

et al., 2023a). Industry 4.0 creates many opportunities to improve the operational efficiency of the circular supply chain and expand other sustainable principles of the business (Chari et al., 2022). On a global scale, Industry 4.0 helps create many new product values and optimize the global supply system (T. Bui et al., 2023b). The breakthrough technologies in Industry 4.0 mentioned are breakthroughs such as: Artificial Intelligence; Internet of Things; Big Data; Cloud; and Blockchain... These technologies mostly have the value of liberating resources and creating extremely high competitiveness of businesses. With the fiercely competitive and rapidly changing nature of the FMCG industry, learning, applying and mastering the tools in Industry 4.0 is a must for businesses.

Vietnam is a country in the emerging economy group. Vietnamese enterprises will have the strength of dynamism and high responsiveness, but the weakness is limited resources and experience. Especially in the challenging FMCG industry, Vietnamese enterprises have a very fast absorption and application of new technologies and trends in the world. However, the limitation of weak experience and resources leads to most enterprises only applying at a coping level, half-heartedly. Vietnamese enterprises need to carefully evaluate the values that each tool in Industry 4.0 brings to them in order to make appropriate investment decisions.

The level of application of SCQM 4.0 by Vietnamese FMCG enterprises

The study aims to synthesize theories to build a scale to help assess the level of awareness of Vietnamese FMCG enterprises. Understanding and applying SCQM in enterprises requires unity and implementation from the leadership level to each department participating in the enterprise's value chain (T. Van Nguyen et al., 2024). Initially, SCQM

was recognized and committed to by the company's leadership team. The leadership team developed long-term strategies and agreed on criteria for measuring the SCQM application process in the business. At the same time, the leadership team also committed to providing resources to help the SCQM application process in the business take place effectively. In the Vietnamese FMCG industry, the supply chain of businesses is the core system that helps create competitive advantages and value for customers in the market.

The effective application of SCQM needs to be continued to middle-level leaders including Production Management; Quality Management; Product Research and Development Management; Sales Management. In particular, the actual implementation of SCQM will be led by Production Management. The operation department of the enterprise is the unit that uses the SCQM system the most in the enterprise. The operation manager will be empowered by the management to implement SCQM in the enterprise. Each process in the value supply chain of an FMCG enterprise needs to be built, implemented and strictly controlled by the production operation team.

Contributing to the effective operation of the value supply chain system, quality criteria will be built, implemented and controlled by the enterprise's quality management department. Many SCQM models are being used by FMCG enterprises such as: Focusing on human resources; focusing on capital; Lean Six Sigma; Knowledge management; Technology 4.0... Next, the SCQM system will be supported by other departments such as: Research and development; human resources; sales. From there, a comprehensive system will be created to help the enterprise operate effectively.

In order to comprehensively assess the level of awareness of Vietnamese FMCG enterprises about SCQM 4.0, the topic needs to conduct a theoretical synthesis process to build a measurement scale. As shared above, the awareness and application of SCQM 4.0 in FMCG enterprises requires the coordination of many different departments in the enterprise. This creates difficulties in collecting data to assess the suitability of the SCQM 4.0 awareness measurement scale. To conduct the research more effectively, the topic has chosen the object of measuring SCQM 4.0 awareness to focus on the senior management of the companies. Although this reduces the comprehensiveness of the research, it helps the topic to be completed with the author's existing resources.

1.4 Significance of the Study

To examine how SCQM 4.0 is being understood and applied in the Vietnamese FMCG sector, this study follows objectives:

- (1). Building a measurement scale in the Vietnamese FMCG industry for: level of implement SCQM; level of implement I4.0; and level of sustainability development of SC.
- (2). To evaluate the impact of SCQM on sustainability outcomes across three dimensions:
 - a. Economic (cost efficiency, distribution capability, responsiveness to market changes),
 - b. Environmental (resource reduction, energy saving, carbon emission reduction),

c. Social (working conditions, fairness, business ethics, employee satisfaction).

(3).To measure the extent to which Industry 4.0 technologies (e.g., AI, IoT, Blockchain, Big Data, ERP, Cloud) have been adopted in the actual operations of FMCG companies and their role in the relationship between SCQM and Sustainability development of SC.

1.5 Research Questions

To achieve the above objectives, the study addresses the following research questions:

RQ1: How to measurement: SCQM; I4.0; and Sustainable Performance of FMCG Vietnam companies?

RQ2: Does SCQM affect Sustainable Performance in a positive way?

RQ3: What role does I4.0 play in the relationship between SCQM and Sustainable Performance in the context of Vietnam FMCG industry?

1.6 Summary

This study considerably enhances supply chain quality management by examining the transformational impact of Industry 4.0 (I4.0) technologies inside Vietnam's FMCG sector:

Initially, it tackles a notable research need by offering an extensive analysis of the integration of I4.0 technologies, supply chain management, and quality management within the FMCG sector, emphasizing the industry's evolution. The establishment of the

theoretical framework, termed Supply Chain Quality Management 4.0 (SCQM4.0), signifies a comprehensive strategy to adeptly tackle the obstacles and possibilities emerging from this integration, particularly within developing countries.

Secondly, this research conducts an empirical examination of the influence of SCQM4.0 practices on a firm's sustainable supply chain performance, emphasizing productivity enhancement, superior product delivery, and resource conservation. It employs dynamic capacity theory, systems theory, and the technical, organizational, and environmental (TOE) framework to establish a complete theoretical foundation for the research.

Finally, the empirical analysis, derived from a dataset of 250 leading experts in Vietnam's FMCG industry, yields significant insights and evidence regarding the potential synergies among I4.0 technologies, supply chain management, and quality management, as well as their effects on sustainability, providing practical implications for both academic and industry sectors and enhancing the theoretical framework.

CHAPTER II: REVIEW OF LITERATURE

2.1 Theoretical Framework

2.1.1 Resource-based View – RBV – and the VRIO Framework

The Resource-Based View (RBV) has emerged as one of the primary explanations for persistent differences in firm performance within the field of strategic management (J. B. Barney & Arikan, 2006). After a period of intense theoretical development and popularization in the early 1990s, the core RBV theory was established and began to influence empirical research. Simultaneously, resource theory expanded its reach into other non-strategic disciplines such as human resource management, marketing, management information systems, and operations research.

At the heart of this perspective is the term “resource.” While defined across various literature (J. Barney, 1991; J. B. Barney, 2001; Rumelt, 1984; Wernerfelt, 1984), current usage suggests that resources are the tangible and intangible assets firms use to formulate and implement their strategies. However, for a resource to truly generate a sustainable competitive advantage, it must be evaluated through the VRIO framework:

Value: According to (J. B. Barney & Arikan, 2006), resources are valuable when they enable a firm to develop strategies that reduce net costs and/or increase net revenues beyond what would have occurred otherwise. Value is also determined by the ability to implement strategies appropriate to the firm's specific markets.

Rarity: A valuable resource that is possessed by many competing firms only leads to competitive parity. Advantage arises when the resource is controlled by a small number of firms.

Inimitability: This represents the barrier to competition. A resource provides a long-term edge only if competitors face a significant cost disadvantage in trying to obtain or duplicate it (often due to unique historical conditions, causal ambiguity, or social complexity).

Organization: Finally, the firm must be organized to exploit these resources. This involves having the systems, processes, and structure in place to capture the full competitive potential of its valuable, rare, and inimitable assets.

In the studies of Rumelt (1984), Wernerfelt (1984), and J. Barney (1991) argues that differences in performance between firms are not primarily due to the products they offer or the market environment in which they operate. Instead, these differences in competitive performance are due to their resources and how these resources are actually used. Industry leaders are most likely to use their resources more effectively than their competitors. Resources are defined here in a broad sense to include both tangible and intangible resources of the firm. Specifically, it is understood here as human resources, financial resources, technology and knowledge, customer relationships and stakeholders of the business. In the opposite perspective, companies without effective resources will be limited in their operations and advantages in the market J. Barney (1991).

Research of Hauschild & Knyphausen-Aufseß (2013) see RBV as a promising tool to study the internal resource needs of enterprises to innovate and improve. Similar to the external resources of enterprises, Kraaijenbrink et al (2010) proposed that the internal resources of the enterprise need to be observed in tangible and intangible forms and in addition the capabilities of the enterprise. According to research by Zhu et al (2014), When observing enterprises in China, the authors concluded that the lack of internal resources according to RBV theory has a negative impact on the intention and behavior of sustainable transformation. Specifically, those factors are listed as: the lack of tangible resources of enterprises; the lack of intangible resources of enterprises and the lack of capacity of enterprises.

In conclusion, resources encompass the tangible assets, intangible assets, and existing capabilities of a firm. By aligning these elements within the VRIO logic, a firm can transform its internal strengths into a foundation for long-term superior performance.

2.1.2 System theory

This research utilizes systems theory to examine the intricate interdependencies within multi-dimensional systems like SCQM 4.0, establishing a theoretical basis for incorporating technological innovations into Supply Chain Quality Management. A firm's competitive edge hinges on its proficiency in managing both internal and external linkages. According to (Grant, 1996), organizations function as holistic entities where value creation depends on high-level integration and robust communication between diverse business activities. Systems thinking facilitates the identification of various supply chain

stakeholders and their interconnectedness (Piercy & Rich, 2015), while also clarifying how the system behaves dynamically in response to its environment (Oehmen et al., 2009).

Furthermore, effective supply chain management requires enhancing performance at both the micro (individual firm) and macro (entire supply chain) levels (Gorane & Kant, 2015). Value generation is thus a product of two layers: the 'sub-systems' (specific processes and firms) and the 'supra-system' (the collective supply chain network) (Fatorachian & Kazemi, 2021). By fostering collaboration across these sub-system components, the overall efficiency of the supra-system the end-to-end supply chain is significantly amplified. Ultimately, systems theory justifies the convergence of Industry 4.0 technologies and SCQM, as technical synchronization between subsystems is vital for seamless information dissemination and superior performance (Fatorachian & Kazemi, 2021). Put simply, by enhancing connectivity and collaboration among sub-system elements, such as between various functions and processes within organizations and between whole supply chain's actors, the performance of the supply chain could be drastically enhanced. Therefore, overall supply chain excellence necessitates the integration of all parties and processes within the supra-system, which refers to the firms involved in the supply chain (Alter, 2008). According to (Mele et al., 2010), increased integration across subsystems may result in the construction of an integrative supra-system, namely an end-to-end supply chain. This integration facilitates a significant level of information flow throughout the value creation process.

From a technical perspective, the effective functioning of a supra-system necessitates the alignment and integration of the technological advancements and

information systems of its subsystems (processes/firms) (Fatorachian & Kazemi, 2021). This may provide efficient networking and synchronized information dissemination, hence resulting in enhancements in performance. To facilitate harmonious interactions across processes within the supra system, it is essential to take into account the technological integration of constituent activities, namely supply chain processes in this particular context (Mele et al., 2010). Therefore, System theory provides a firm theoretical framework supporting the integration between Industry 4.0 Technologies and SCQM into SCQM4.0.

2.1.3 Technology-Organization-Environment framework

As elucidated in the preceding section, the dynamic capabilities theory and system theory serve as the theoretical underpinnings for the establishment of SCQM4.0. This highlights the significance of developing SCQM4.0 in order to ensure the enduring viability and prosperity of enterprises operating within the supply chain. From an alternative perspective, the TOE framework offers a theoretical and thorough foundation for identifying the success factors associated with the development of SCQM4.0. This is achieved by examining SCQM4.0 via three distinct perspective: Technological capacity, Organizational factors, and Environmental factors.

On the other hand, the Technology-Organization-Environment (TOE) model proposes a comprehensive perspective on the determinants of technology adoption choices. This model incorporates external elements related to the environment, internal factors related to the organization, and technical qualities to forecast decisions on the adoption of innovations within an organizational context. Therefore, given the integration between SCQM and Industry 4.0 technologies into SCQM4.0, the TOE framework could provide

strong theoretical background from which multiple success factors for this integration could be defined.

2.2 Logistics

At its core, logistics is not merely transportation; it is a strategic system of flow management designed to create time and place utility. In 2004, Mentzer et al. distinguishes logistics as a specific set of functional activities (transportation, warehousing) nested within the broader framework of Supply Chain Management (SCM) (Mentzer et al., 2004). Furthermore, (Ballou, 2007) emphasizes that logistics contributes "added value" to a product. If a product is not available when a customer wants it or at the specific location they desire, the product effectively holds zero value in that context. Until 2016, we received the full Logistic definition by Christopher in Logistics & Supply Chain Management: "Logistics as the process of strategically managing the procurement, movement, and storage of materials, parts, and finished inventory to maximize current and future profitability through cost-effective order fulfillment". This definition leveraged Logistic from playing a supporting role to becoming a key element in FMCG's businesses.

Logistics transformed from isolated "silos" to seeing it as a seamless, integrated process. In 2015, Enz and Lambert asserted that modern logistics management requires cross-functional coordination between marketing, manufacturing, and finance to balance customer service levels against total system costs (Enz & Lambert, 2015). In competitive environment, Spillan and Mc. Ginnis argued that "logistical integration" allows firms to achieve a higher advantage by linking previously fragmented activities into a synchronized process from supplier to end-user (Spillan et al., 2013). Research by Fawcett et al. identifies

"information sharing" as the catalyst for successful integrated logistics, helping to mitigate the "bullwhip effect" across the supply chain. So modern Logistic included both product driveway and information sharing (FAWCETT et al., 2011).

From Industrial Revolution 4.0, we focused on information enhancement tools which support modern logistics most. A lot of trending term were created such as Smart Logistic; Logistic 4.0... which named the logistic system enhanced automation and data-driven intelligence. In 2017, Barreto et al. defined Logistics 4.0 as the application of technologies such as the Internet of Things (IoT), Cyber-Physical Systems (CPS), and Big Data to create self-adjusting and intelligent logistical systems (Barreto et al., 2017). Especially in FMCG environment, almost companies applied IoT in their logistic system which consumed thousands of million dollars without any profit promising. In Ben-Daya et al. study on IoT and Logistics, highlight that smart devices enhance "supply chain visibility," allowing for the real-time tracking of goods and environmental conditions (Ben-Daya et al., 2019). In 2022, Ivanov et al. argued that digitalization does more than just increase efficiency; it builds "supply chain resilience," enabling firms to withstand market shocks like the COVID-19 pandemic. After Covid-19, we observed companies which apply information sharing technology before pandemic had faster recovery time. This is evidence for Logistic 4.0's efficiency in real life (Ivanov et al., 2022).

After new technology era, modern logistics, also known as green logistics, only focused on the more environmentally friendly system. Because FMCG's logistics are usually tied with pollution, harmful to environment and other negative impacts. In 2003, Sarkis developed a strategic framework for green supply chain management, emphasizing

"reverse logistics" as a core component for achieving sustainability. In this framework, Sarkis focuses on logistics' core components and tried to reduce environment impact of these items (Sarkis, 2003). Until 2008, the "Triple Bottom Line" framework in logistics, requiring companies to balance Economic (Profit), Social (People), and Environmental (Planet) factors simultaneously was introduced by (Carter et al., 2019). McKinnon analyzes strategies to decouple economic growth from the environmental impact of freight transport, focusing on carbon footprint reduction. This research linked modern logistics to the sustainable development of humanity with carbon footprint which is most produced by FMCG's logistic systems (McKinnon, 2007).

In modern management theory, sustainability has evolved from a "corporate social responsibility" elective to a core strategic necessity for long-term competitive advantage. We focused on three pillars of sustainability: Environmental; Social; and Economic Sustainability.

Environmental Sustainability: Not only carbon footprint, sustainability logistic focused on wider landscape of logistical operations through decarbonization and resource efficiency. Companies can use current data on multi-resources for monitoring and creating reduced strategy CO₂ emissions by FMCG's Logistic systems. On the research of Piecyk & Björklund emphasize that the transition to zero-emission freight (Electric & Hydrogen-powered vehicles) and the adoption of renewable energy in warehousing are the top priorities for logistics firms in this decade (Piecyk & Björklund, 2015).

Social Sustainability: Companies are not working alone; we should zoom out the view to stakeholders who support the logistic system. Logistical activities should have a

positive impact on employees, stakeholders, and the broader community. In 2018, Mani et al. argue that social sustainability in logistics encompasses labor safety, ethical procurement, and the well-being of drivers and warehouse staff. Improving these factors reduces turnover rates and boosts overall productivity. The essential to maintain the positive impact to stakeholders is transparency (Mani et al., 2018). In 2022, Tuni et al. highlight that Supply Chain Transparency is the primary mechanism for firms to prove compliance with fair labor standards and avoid human rights violations within lower-tier supply networks (Tuni & Rentizelas, 2022).

Economic Sustainability: Last, we have economic angle in Sustainability Logistic. This involves maintaining profitability through resource optimization, risk management, and long-term value creation. By investing on new technologies (sustainable technologies), Sarkis affirmed that companies achieve higher economic benefits through energy savings, waste reduction, and increased brand loyalty from "green" consumers (Sarkis, 2025). Toriro and Banhire introduced the concept of "Resilience-as-Sustainability," suggesting that a supply chain's ability to recover from shocks (such as pandemics or climate-related disasters) is a fundamental form of economic sustainability (Toriro & Banhire, 2021).

2.3 Quality Management Practices (QM)

Quality management is considered a comprehensive management philosophy that integrates principles, practices, and technologies to improve business performance (Bouranta et al., 2017). In this system, principles play a guiding role, concretized through practical activities with strong support from a technological platform (Zeng et al., 2015). To adapt to global competitive pressures, managers need to apply this philosophy to

optimize performance and build sustainable competitive advantages (Boateng-Okrah & Appiah Fening, 2012) Although there is still much debate about the core components of quality management, this study has synthesized and proposed a model of eight key elements suitable for the manufacturing industry: from leadership commitment, human resource management, customers, and suppliers to training, data analysis, process management, and product design.

The core objective of applying quality management practices is to promote operational performance, thereby creating a competitive advantage in the market. Therefore, studies in this field often focus on impact models, in which quality management practices act as the independent variable and performance is considered the dependent variable. Current scholars often approach the issue in two ways: either viewing quality management as a unified whole or separating it into multiple spatial dimensions based on different principles for multidimensional analysis (Kharub et al., 2019).

Scholars have proposed various approaches to classifying total quality management practices. For example, Flynn et al. divided them into two groups: infrastructure quality management (focusing on social and communication aspects) and core quality management (more focused on tools and techniques) (Flynn et al., 1994). Similarly, Prajogo and Sohal differentiated them into "mechanical" and "organic" factors, demonstrating their influence on quality performance and innovation through empirical research (Prajogo & Sohal, 2004). Furthermore, Kaynak and Hartley classified them according to internal and external scope to measure their distinct impacts on financial, market, and warehouse management outcomes (Kaynak & Hartley, 2008).

2.4 Supply Chain Quality Management (SCQM)

The convergence of Supply Chain Management (SCM) and Quality Management (QM) has led to the emergence of Supply Chain Quality Management (SCQM), marking a shift from purely operational functions to a strategic paradigm. Historically, SCM originated from logistics, with a primary focus on containerization and intermodal transport management. This evolved into production and distribution management, where computational advancements optimized warehousing, inventory control, and logistics routing. The subsequent implementation of Enterprise Resource Planning (ERP) systems revolutionized the field by integrating fragmented databases and improving data precision for complex logistical scheduling. In the contemporary era, SCM has expanded into a strategic discipline addressing global challenges, such as managing intricate international networks, outsourcing complexities, product recalls, and corporate social responsibility (Cooper et al., 1997; Narasimhan et al., 2013; Wieland et al., 2016).

Initially, quality was ensured by evaluating items for flaws before their market release. Subsequently, incremental quality control transcends the mistake detection method, evolving into a more systematic strategy that addresses quality concerns through the application of statistical tools indicative of quality management. The notion of quality assurance has broadened the accountability for quality beyond organizational functions towards strategic objectives, employing more advanced statistical methodologies (Mitra, 2016) Total Quality Management (TQM) addresses customer requirements and positions quality as a strategic and pervasive concern inside the organization, engaging both customers and suppliers (Cogollo-Flórez & Correa-Espinal, 2019; Zimon et al., 2019).

Since the 1980s, several firms have embraced QM as a crucial method for achieving competitive advantage. Quality Management (QM) guarantees that businesses focus on the pertinent and significant issues, according to the principles of "doing things correctly," "doing the right things," "doing the right things the first time," and "doing the right things consistently." Initially, meeting customer expectations for product design and performance requires Quality Management (QM) to concentrate on the internal perspective of quality associated with the management of the manufacturing process, production, and products (Mellat-Parast, 2013; Sousa & Voss, 2002).

The globalization of supply chains and decentralization of production necessitate that leveraging the potential of Quality Management (QM) demands equal focus on both upstream and downstream supply chain operations (Zeng et al., 2015). The quality of a product is contingent upon the quality procedures of both the producer and the suppliers, as well as the comprehension of client requirements (Fernandes et al., 2022). Consequently, QM serves as an efficient mechanism for enhancing SC operations by ensuring ongoing performance enhancement across the SC, ultimately resulting in elevated customer satisfaction levels. However, this necessitates that Quality Management is not limited to internal operations but also encompasses both upstream and downstream activities. Upstream QM activities encompass enduring relationships with suppliers, their participation in product development and quality enhancement, as well as the selection and certification of suppliers with an emphasis on quality. Conversely, downstream QM operations encompass routine meetings with clients or surveys to ascertain consumer requirements, soliciting customer input on quality concerns, and engaging customers in

product design, among other tasks. The flawless synchronization of quality management systems across the supply chain is of paramount importance. Supply Chain Quality Management (SCQM) is an advancement that emphasizes the significance of combining Supply Chain Management (SCM) with Quality Management (QM). Robinson and Malhotra (2005) assert that Supply Chain Quality Management (SCQM) entails the systematic coordination and integration of business processes among all partner organizations within the supply chain, aimed at measurement, analysis, and continuous enhancement of products, services, and processes to generate value and attain optimal customer satisfaction in the marketplace.

Broadly defined, SCQM serves as a systems-centric framework for optimizing performance, aiming to synchronize the best practices of SCM and QM. This integration is designed to capitalize on the collaborative opportunities found within upstream supplier and downstream customer networks (Foster & Ogden, 2008). Scholarly interpretations of SCQM have evolved over time; notably, (Ross, 2017) pioneered investigation into how supply chain stakeholders can align their commitments to refine processes and organizational culture, ultimately maximizing customer value. Furthermore, empirical evidence from various studies reinforces the existence of a significant positive correlation between the adoption of SCQM practices and enhanced organizational outcomes (Kuei et al., 2001; C. Lin et al., 2005; Soares et al., 2017)

The literature generally agrees on the benefits of integrating SCM and QM practices. Quality improvement across the supply chain not only lowers costs but also enhances process efficiency. Both strategic and operational levels, there is a strong

relationship between supply chain management and quality management within organizations. These two areas are considered integral to operational strategy, with a shared commitment to quality and a recognition that supply chain dynamics significantly influence performance. Studies have specifically highlighted the benefits of this integration, showing that QM can serve as a driver for improving overall supply chain performance (Flynn et al., 2010). From a QM perspective, SCM can be understood as the delivery of quality products and services to every entity in the supply chain to meet customer expectations (Parast, 2019). Since both QM and SCM ultimately aim for “customer satisfaction,” their integration strengthens the performance of each, leading to higher levels of customer satisfaction within the organization (Meidutė-Kavaliauskienė et al., 2014).

Nevertheless, research on integrating all three dimensions of SCQM are internal processes, upstream QM, and downstream QM remains scarce (Zeng et al., 2015), along with methodologies for managing every activity and relationship among all supply chain stakeholders. For instance, Fernandes et al. emphasized that effective SCQM implementation requires shared practices between QM and SCM, including leadership, information systems, management and strategic planning, stakeholder engagement and commitment, continuous improvement, and innovation, all of which contribute to enhancing organizational performance (Fernandes et al., 2022).

Table 2.1 below summarizes key SCQM studies from two perspectives: the descriptive model and the rule-based model. The descriptive model is static, portraying the actual state of a system at a given point in time and utilizing quantitative techniques such as regression analysis and pattern recognition. The rule-based model, on the other hand,

involves introducing dynamic rules to explain observed system behavior, enabling predictions of potential system states using equations, dynamic rules, and principles, combined with other quantitative methods (Binh et al., 2025).

Table 2. 1 Summarizes key SCQM studies

Authors	Methods	SCQM practices	Outputs	Results
Cheung and Leung (2000)	Rule-based models - mathematical model	Policy control Inventory; Quality issues in production.	Cost saving - (Cheung & Leung, 2000)	The results presented in this paper show the optimal sampling plans under coordinated replenishment. It has been recognized that owing to the variation in the number of each item in each incoming lot, the sampling plan is more complex than that of the case when items are individually replenished. The complexity raises the quality-related cost,

				thereby impeding cost saving owing to coordinated replenishment shrinks.
Tsai and Wang (2004)	Rule-based models - model of collaborative quality control	Established the Collaborative Quality Control (CQC) model and technology transfer	Product quality - (Cheung & Leung, 2000)	Product specification, process marginality, process harmonization, and all CQC functions based on all process baselines from different suppliers show no difference.
Das and Sengupta (2010)	Rule-based models - mathematical model	Method: Applying a quality-oriented coordination process and a mathematical model between partners	Profit orientation - (Das & Sengupta, 2010)	Ensuring the 'right product, right time' through effective dispatching and distribution.

		Goal: Developing an effective supply chain (SC) network.		
Bayo et al. (2011)	Descriptive models - probit models and least square models	Internal - external quality assurance variables	Suppliers' geographic locations - (Bayo-Moriones et al., 2011)	The model's static and descriptive nature excludes mediating variables between supplier localization and quality assurance.
Xiao, Yang, and Shen (2011)	Rule-based models - mathematical model	Manufacturer coordinates the service quality, and retail price decisions when facing consumers with heterogeneous sensitivity to product quality	Profit contracts - (Xiao et al., 2011)	Limited by its 'zero lead time' assumption and lack of competitive analysis, the model does not reflect the reality of mass consumption or non-MTO industries.

		in an MTO supply chain. In addition, giving the Pareto condition of the coordination mechanism by comparing the profits of the players in the coordinated and no coordinated settings.		
Yoo, Kim, Park (2015).	Rule-based models - coordination model	Investigating a joint decision problem of the return policy and product quality in a buyer-supplier supply chain.	Providing managerial insights into practice - (Yoo et al., 2015)	By focusing solely on quality and return policies, the model fails to account for broader objectives such as overall performance and customer satisfaction.

Chaghooshi et al. (2015)	Descriptive models - correlational descriptive model	Operate inter organizationally and merge strategic with upstream and downstream flows.	Excellence of business - (Chaghooshi et al., 2015)	The study confirms a significant link between SCQM and competitive advantage, highlighting 'customer focus' and 'quality' as the primary drivers.
Pang and Tan (2018)	Rule-based models - Nerlove-Arrow model	Quality levels investigation on goodwill and product sales.	A number of insights into aspects of decision making - (J. Pang & Tan, 2018)	The study reveals that traditional cooperation fails in competitive markets, whereas supplier-manufacturer integration can boost profits for all channel members.
Padiyar, et al. (2022)	Rule-based models - single-vendor multi-buyer supply chain model	Future model expansions should include multi-echelon and multi-item supply chains,	Unit production cost - (Padiyar et al., 2022)	The experimental results represent the reduction of MTTF with increasing production rate which has a considerable influence on obtaining

		while accounting for inspection errors and lot- based inspection.		the managerial decisions in a centralized supply chain model with manufacturing.
--	--	--	--	---

Source: by Author

2.4 I4.0 technologies in SCQM

Extensive literature suggests that integrating Industry 4.0 technologies within Supply Chain Quality Management (SCQM) frameworks substantially boost organizational sustainability (Fernando et al., 2022). This synergy empowers enterprises to more effectively oversee and manage the environmental and social consequences of their logistics activities. Specifically, I4.0-driven SCQM enables the identification of critical manufacturing variables that facilitate the reduction or total elimination of greenhouse gas (GHG) emissions and carbon footprints (Bag et al., 2021; Bai et al., 2015). Through the deployment of sophisticated digital tools including Blockchain, IoT, and Artificial Intelligence firms can systematically gather and evaluate metrics vital to green supply chain success, such as energy efficiency and labor safety standards (Dev et al., 2020; Esmaeilian et al., 2020). Ultimately, these technological integrations not only ensure compliance with global regulations and consumer demands but also drive significant cost reductions and competitive advantages.

Ross regarded information technology (IT) as essential for efficient supply chain quality management. The enormous influence of IT on supply chain quality is indisputable, as it can internally integrate diverse processes and, more importantly, externally interact with suppliers and consumers (Ross, 2017). This has been accomplished through enhanced data capture and transfer in communication, hence promoting efficient decision-making and improving supply chain quality. Focus on:

- Blockchain in SCQM4.0
- The Internet of Things in SCQM4.0
- Traceability technologies in SCQM4.0
- Smart packaging technology in SCQM4.0

2.3.1 Blockchain in SCQM4.0

Establishing a robust traceability system is a practical approach to reducing the harmful impacts caused by the production and distribution of unsafe or low-quality goods, while also strengthening the organization's reputation. In addition, consumers increasingly view verified traceability as a key indicator of product quality. Recently, numerous publications have examined Blockchain-based approaches for building effective traceability systems. For instance, Blockchain can be used to identify the source of defects in the event of a product recall. Table 2 summarizes this stream of research. For the purposes of our scope, Blockchain becomes particularly relevant when integrated with IoT technologies.

Most studies in the SCQM4.0 literature link Blockchain implementation to risk reduction and enhancements in supply chain quality management. The authors highlight

the advantages of a Blockchain-powered platform in optimizing quality across the supply chain. In 2017, Chen identified Blockchain as a means to counter skepticism in supply chain quality management (Chen et al., 2018). Blockchain provides a foundation for immutable anti-fraud measures, secure information and data handling, and most importantly traceable records are established through standardized agreements and rules. By employing a decentralized structure, this technology enables multiple stakeholder groups to share authority within a unified IT system. The combination of IT capabilities and governance mechanisms contributes to improving both product and service quality throughout the supply chain.

Table 2. 2 Blockchain supply chain research

Blockchain supply chain research topics	References
Framework for intelligent Blockchain-based SCQM	(Chen et al., 2018)
Supply chain traceability system based on Blockchain and IoT technology	(Caro et al., 2018; Feng Tian, 2016; J. Lin et al., 2018; J. Wang et al., 2017)
SC traceability system based on HACCP (Hazard Analysis and Critical Control Points), Blockchain and Internet of things	(Feng Tian, 2016)

Blockchain and smart contracts implementation (Galvez et al., 2018)
challenges

Source: by Author

2.3.2 The Internet of Things in SCQM4.0

The Internet of Things (IoT) has sparked a fundamental transformation in information technology, significantly impacting various fields such as quality management (QM). In the context of supply chains, IoT facilitates advanced connectivity between individuals and physical objects, allowing for autonomous coordination during storage and transit (Ben-Daya et al., 2019). According to Ellis, this technology improves organizational agility, visibility, and responsiveness, providing novel solutions for quality-related issues (Hoessler et al., 2023). By converting raw data from smart sensors into strategic insights, companies can achieve comprehensive oversight of the supply chain, enabling early detection of anomalies and swift corrective actions to bolster overall quality.

In the context of SCQM4.0, this capability is especially critical, as IoT shortens the gap between data acquisition and decision-making. It also enables rapid action in the event of recalls or product quality concerns. Additionally, IoT supports remote management of supply chain quality functions such as after-sales services and maintenance while improving partner collaboration, accelerating tracking and tracing, and ensuring decision-makers have greater access to accurate and reliable information.

While IoT offers significant benefits, its integration into SCQM4.0 is hindered by several critical barriers. The massive data throughput necessitates advanced hardware, software, and robust security protocols. Furthermore, the lack of universal standardization

across platforms creates financial uncertainty, discouraging large-scale investment. According to (Badia-Melis et al., 2018) this absence of uniformity forces companies to adopt fragmented, case-by-case implementations tailored to specific product types. Additionally, (Kamble et al., 2020) highlight those external factors, such as underdeveloped internet infrastructure and a lack of clear government regulations, further complicate adoption. A summary of contemporary IoT-driven frameworks in supply chain management is detailed in Table 2.3.

Table 2. 3 Main IoT-based solutions and frameworks for the SCQM4.0

IoT based solutions and frameworks	References
IoT systems application:	
Monitoring agricultural products' quality and safety.	(Satrio Wicaksono et al., 2022)
Cold supply chain monitoring: Applied IoT	(Tsang et al., 2018)
Cargo monitoring system for product quality: Applied IoT	(Tsang et al., 2018)
Real-time temperature monitoring in supply chain: Applied RFID and Critical Temperature Indicators	(Lorite et al., 2017a)
Product traceability system: IoT applied in duck production	(Liu et al., 2018)
Cold supply chain's tracking system based on IoT	(Luo et al., 2016)
Cold supply chain's RFID monitoring	(Turcu, 2010)

Optimization revenue of perishable product supply chain with the IoT.	(Yan, 2017)
IoT frameworks:	
Value-centric business and technology	(Z. Pang et al., 2015)
Information system architecture in Logistic: Applied IoT	(Verdouw et al., 2018)
IoT based framework for supply chain planning	(Accorsi et al., 2017)
Supply chain virtualization	(Verdouw et al., 2018)
A hierarchical data architecture in sustainable landscape	(Accorsi et al., 2018)
How to evaluate Green level by IoT for agricultural products	(Wang, 2018)

Source: by Author

2.3.3 Traceability technologies in SCQM4.0

According to the United Nations Global Compact and Business for Social Responsibility, traceability is defined as “the ability to identify and trace the history, distribution, location, and application of products, parts, and materials, to ensure the reliability of sustainability claims, in the areas of human rights, labor (including health and safety), the environment, and anti-corruption.” Traceability serves as a fundamental mechanism for maintaining control over supply chain (SC) operations and supporting effective follow-up processes (Mofatteh et al., 2024). Its implementation is often shaped by the nature and sector of the product being managed within the SC. As noted by Sirkka,

the supply chain constitutes a complex network characterized by openness, emergence, and dynamic interactions factors that can lead to interruptions and disruptions (Sirkka, 2008).

Emerging technologies such as Blockchain have been identified as promising solutions for implementing traceability, offering the capability to establish secure, immutable information trails across the SC (Abbate et al., 2022). This capability is particularly critical in scenarios requiring rapid prevention or response, such as incidents of food contamination, human or animal illness, the presence of medication or pesticide residues, or threats of bioterrorism. Table 2.4 consolidates the main research trends and applications of traceability in SCQM 4.0 for improving quality management in the supply chain.

Table 2. 4 Main traceability research trends and findings in SCQM4.0

Traceability research issue	References
Traceability systems applications:	
RFIDs	(Qian et al., 2012)
RFIDs with PDA and barcodes	(Feng Tian, 2016)
"Gapless" traceability with RFIDs	(Mainetti et al., 2013)
Cold supply chain	(Óskarsdóttir & Oddsson, 2019)
Traceability for quality	(J. Wang et al., 2017)
Traceability for safety and security	(S. Xiao, 2023)
Value of traceability to consumers	(Jin et al., 2017)

RFID applications: Traceability in logistics (anti-counterfeit operations)	(Dabbene et al., 2014)
The difficulty in solving the heterogeneous nature of the supply chain	(Badia-Melis et al., 2015)

Source: by Author

2.3.4 Smart packaging technology in SCQM4.0

The terms smart packaging (SP) is often used interchangeably or misinterpreted when describing modern packaging systems. SP is a broad concept that incorporates both intelligent packaging which monitors internal and external changes in a product and active packaging, which responds to these changes by communicating with an external interface, such as electrical or optical systems (Vanderroost et al., 2014). The primary aims of SP include extending the shelf life of goods, maintaining freshness, exchanging quality-related information with consumers, enhancing product safety, and improving traceability throughout the supply chain.

Technological advancements in product safety have been recognized as a key measure for reducing the loss and waste of goods (Vilariño et al., 2017). In recent years, SP technologies have been increasingly adopted in the pharmaceutical and consumer goods industries, complementing traditional packaging functions. These innovations not only extend the shelf life of goods but also streamline production processes, reduce the need for preservatives, minimize waste, and enhance product diversity and quality to ensure consumer safety and satisfaction (Janjarasskul & Suppakul, 2018; Vilariño et al., 2017).

Recent developments have introduced a variety of cost-effective and versatile SP solutions to meet growing consumer expectations for quality and safety. Simple, printable tools such as barcodes, QR codes, and colored tiles are emerging as affordable alternatives or supplements to RFID technology, particularly for small-scale applications. Confidential QR codes, for example, can assign unique identifiers to goods, enable pallet and package tracking, and be scanned using devices ranging from smartphones to industrial cameras. To counterfeit, manufacturers have adopted modified images and unique pattern recognition, which can be authenticated using specialized digital software, ensuring the integrity of goods in the market. Table 5 summarizes the key issues and challenges associated with implementing smart packaging solutions in the supply chain.

Table 2. 5 Literature review of Smart packaging

Research issues	References
Different types of CO2 sensors	(Puligundla et al., 2012)
Photochromic time temperature indicator (TTI) to monitor the time temperature history	(Brizio & Prentice, 2014)
Smart time-temperature indicator	(Lorite et al., 2017b)
Product tracking using IoT technology	(Tsang et al., 2019)
Intelligent packaging to reduce waste	(Haas et al., 2015)

Source: by Author

2.5. Operational Excellence in Sustainable Supply Chains Performance

The notion of a sustainable supply chain emerged alongside sustainable development, since literature indicated that a company's supply chain has a greater environmental influence than its internal operations (Cui & Wang, 2022; Fritz, 2022). Furthermore, there remains ongoing discourse on the implementation of a more stringent regulatory framework concerning the environmental impacts associated with the company's supply chain among foreign governments, lawmakers, regulatory agencies, and investors. Our study introduces an innovative methodology for assessing sustainable performance in the supply chain by integrating economic, social, and environmental dimensions, along with regulatory considerations, in accordance with the framework established by Chardine-Baumann and Botta-Genoulaz, which has been extensively utilized across various fields in numerous studies (Chardine-Baumann & Botta-Genoulaz, 2014).

Undoubtedly, the adoption of Industry 4.0 technology, guided by dynamic capability and system theory, defines sustainable performance as the degree of dynamic logistics networks, flexibility, automation, and other factors necessary to attain alignment with both the business environment and consumer needs. The economic objectives are to (1) establish dynamic logistics networks that enhance the flow of goods while minimizing the environmental impact of transportation (Giusti et al., 2019), (2) improve distribution by decreasing lead times through the implementation of expedited transportation systems, ensuring timely delivery of products to customers (Ding et al., 2021), (3) augment the level of automation in operations to boost efficiency and lessen dependence on manual labor

(Klumpp et al., 2019), and (4) attain high flexibility by fostering innovation, adapting to fluctuations in market demand, and continuously refining products and services to satisfy the changing needs of customers (S. Ahmed et al., 2021).

Environmental performance relates to the impact that business activities have on the natural environment. The primary goal is to reduce the consumption of natural resources in order to minimize environmental harm (Danish et al., 2019). This involves lowering the use of raw materials, water, and energy within production processes. Another focus is on managing carbon emissions that result from waste management, waste disposal, packaging, and recycling activities (Marrucci et al., 2020). Efforts to cut greenhouse gas emissions include applying technological advancements across the entire supply chain (Manupati et al., 2020). Furthermore, with the support of I4.0 technology and the integration of supply chain quality management, this approach emphasizes reducing energy consumption by utilizing energy-efficient equipment, adopting renewable energy sources, and optimizing energy usage in all business operations (Dantas et al., 2021). Finally, we set a strong intention to increase the share of renewable energy in distribution, for instance, through the use of electric vehicles and installing solar panels to power warehouses and distribution centers (Nunes & Matias, 2020).

Social performance pertains to the influence of corporate activities on society (Bennett et al., 2000). We acknowledge the influence of technological progress on work behavior and guarantee our staff receive appropriate training to adapt to changes (Petrou et al., 2018). We offer training and upskilling opportunities to ensure staff have the requisite skills to adapt to emerging technology. Secondly, we want to enhance our company brand

by committing to ethical business practices, ensuring transparency in our operations, and advocating for social and environmental sustainability (Gomez-Trujillo et al., 2020). Thirdly, we endeavor to maintain safe working conditions for all employees and to eliminate any kind of discrimination in the workplace (Celma et al., 2018). We do not employ child labor or forced labor in any facet of our business (Nayak et al., 2019). We adhere to legislation and corporate ethics to foster equitable competition and support the sustainable growth of the enterprise (Singer, 2018). Ultimately, although promoting the incorporation of sophisticated technology, we remain vigilant regarding the inequity it generates inside the supply chain. Consequently, we prioritize the promotion of an equitable and socially inclusive society by endorsing social initiatives, engaging in community development endeavors, and cultivating a diverse and inclusive workplace that ensures equal opportunity for all workers (Tate & Warschauer, 2022)

Operational excellence (OE) has emerged as a critical enabler for advancing sustainability in supply chains (SCs). Traditionally, operations management focused primarily on efficiency, effectiveness, and cost reduction. However, growing pressures from governments, stakeholders, and the United Nations' Sustainable Development Goals (SDGs) have pushed organizations to integrate ecological and social dimensions into their operational strategies (Bag et al., 2025). The Sustainable Supply Chain (SSC) framework thus emphasizes a Triple Bottom Line (TBL) approach, combining economic, environmental, and social performance metrics.

Recent research highlights that OE practices such as Lean, Six Sigma, reverse logistics, and quality management systems play a central role in embedding sustainability

within SSCs (Farias et al., 2019; Li et al., 2013). Moreover, disruptive technologies including Big Data Analytics, Blockchain, Internet of Things (IoT), and Industry 4.0 tools enhance supply chain transparency, traceability, and resilience, thereby enabling more sustainable decision-making in areas such as production planning, sourcing, and logistics. Similarly, concepts from the Circular Economy (CE) provide complementary pathways for resource optimization, waste reduction, and closed-loop operations (Gaustad et al., 2018; Sehnem et al., 2019).

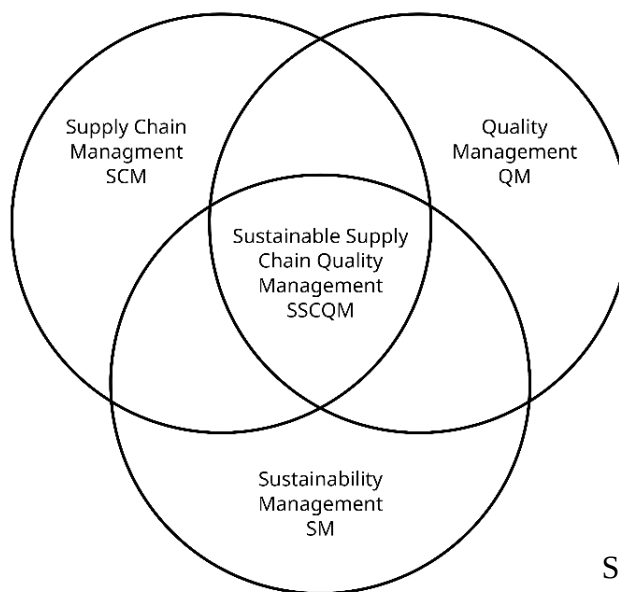
The integration of OE with SSCM contributes significantly to business competitiveness, supply chain flexibility, collaboration, transparency, and innovation (Mangla et al., 2019). At the same time, it facilitates the use of impact assessment tools such as life cycle assessment (LCA), environmental management systems, and carbon footprint evaluations to monitor and mitigate ecological impacts (Farias et al., 2019). However, despite these advances, challenges remain. Managers must address trade-offs between economic efficiency and sustainability goals, overcome barriers to IT adoption, and manage behavioral and organizational factors that influence the adoption of SSCM practices (Akbar et al., 2020; Chakraborty & Dey, 2024).

2.6. Sustainable Supply Chain Quality Management (SSCQM):

In the context of globalization and increasing pressure from customers, regulators, and society, firms can no longer focus solely on profitability or product quality in isolation but need a more holistic management approach. For this reason, three major theoretical streams have been integrated to form the foundation of **Sustainable Supply Chain Quality Management (SSCQM): Quality Management (QM), Supply Chain Management**

(SCM), and Sustainability Management (SM) (Bastas & Liyanage, 2018b). First, QM provides systematic tools and principles such as ISO 9001, Six Sigma, and the PDCA cycle to ensure continuous improvement, process efficiency, and customer satisfaction. Second, SCM extends the scope of management to the entire value network, emphasizing integration, coordination, and information sharing across firms to enhance collective performance (Robinson & Malhotra, 2005b; Vanichchinchai & Igel, 2009). Finally, SM adds a critical dimension through the **triple bottom line (economic, social, and environmental)** perspective, which requires firms to balance profitability with social responsibility and ecological preservation (Rajeev et al., 2017; Seuring & Müller, 2008a). When combined, these three theoretical foundations position SSCQM as a comprehensive management model that simultaneously assures product and service quality, optimizes supply chain operations, and supports long-term sustainable development for firms and their stakeholders (Bastas & Liyanage, 2018b).

Figure 2. 1 Framework of Sustainable Supply Chain Quality Management



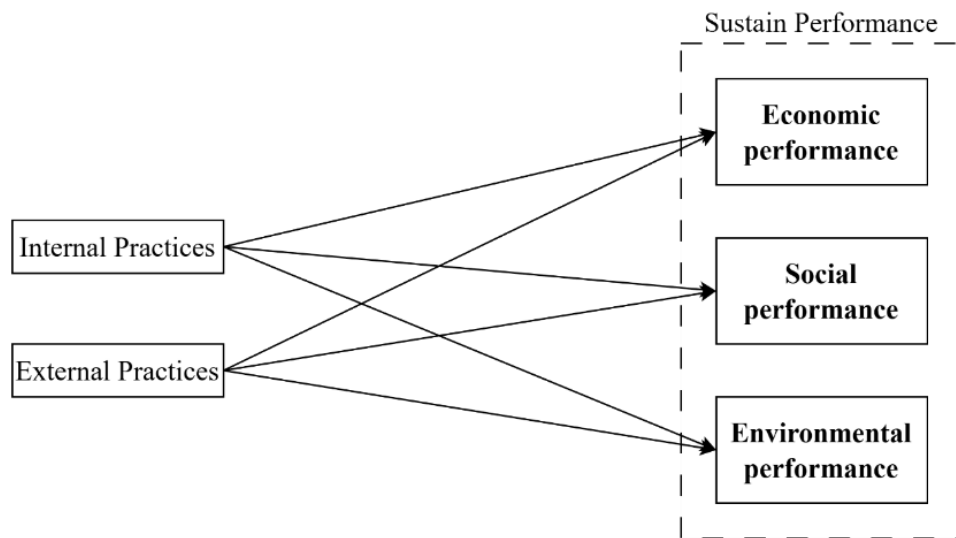
Source: by Author

2.7. Conclusion

Combining System Theory and TOE, this study synthesizes aspects of Supply Chain Management and Quality Management into Supply Chain Quality Management (SCQM). The study also utilizes RBV theory to propose the impact of SCQM 4.0 aspects on Sustainable Supply Chain Performance. This is the objective of the first research question: “Develop a scale to measure the relationship between SCQM 4.0 and Sustainable Supply Chain Performance (SDP).”

The proposed SCQM 4.0 classification model consists of two groups: Internal Practices and External Practices. This facilitates more effective responses from respondents in the Vietnamese FMCG industry, as the concepts of Internal Practices and External Practices have long been used in quality management. The proposed model is shown in Figure 2.2 below.

Figure 2. 2 Proposed research model



Source: by Author

CHAPTER 3: METHODOLOGY

3.1 Overview of the Research Problem

Vietnam has a population of over 100 million, ranking 15th in the world (World Bank Group, 2025). Furthermore, with an average age of 28.7 and 70% of the population in the working age group, it is projected that by the end of 2030, approximately 53 million people currently aged 10 to 19 will become the main workforce and consumer base in society. Based on these figures, Vietnam is considered to be entering a period of demographic dividend. Vietnam is seen as a developing country with great potential due to its young and high-quality workforce. Moreover, Vietnam is a developing country with high growth rates in the region. Rising living standards and incomes have led to increased spending power. Despite having recently emerged from an economic recession, Vietnam remains a promising market for the retail sector. Except for the Covid-19 pandemic period, the Vietnamese FMCG industry has shown an upward trend over the years.

With numerous opportunities arising from rising incomes and living standards in Vietnam, the Vietnamese FMCG industry possesses unique characteristics and a high turnover rate. Specifically, according to 2025 statistics, approximately 97% of manufacturing businesses in Vietnam are small and medium-sized enterprises (SMEs). These businesses are expected to experience a temporary suspension or dissolution rate of around 10.1%, while the number of newly registered businesses is projected at 26.5% in 2025. The significant increase in SME businesses is attributed to the rising average living standards and income of Vietnamese people. According to Kantar's 2025 FMCG Vietnam Outlook report, Vietnamese consumer demand is growing both in quantity and quality. In

2025, several laws and policies aimed at improving the quality of commercially traded FMCG products will be introduced, requiring FMCG businesses to adapt accordingly.

Along with these opportunities, Vietnamese FMCG businesses face significant challenges as numerous global retail corporations enter the market. The increasingly improved trade process, with many direct shopping channels from abroad to Vietnam, creates immense pressure on domestic businesses. The rapid and low-cost delivery of goods from overseas to Vietnam is a major headache for domestic FMCG companies. This forces manufacturers to possess supply chain systems that are both error-free and cost-effective. It is for this reason that SCQM (Supply Chain Quality Management) is being seriously researched, invested in, and applied by FMCG businesses.

SCQM represents a strategic fusion of techniques used by organizations to leverage business partnerships between suppliers and customers, aimed at elevating the overall quality of products and services (Ford, 2015). Unlike traditional quality management, which primarily focuses on operational tasks within the organization (Ross, 2017), SCQM emphasizes the strategic aspect of supply chain management, allowing businesses to proactively address quality management issues at every stage of the supply chain, from raw material procurement to final product delivery, encompassing the entire supply chain network (Bastas & Liyanage, 2018b). The shift from business unit specialization to collaborative spirit fosters coordination within SCQM, thereby enhancing customer satisfaction and product quality (Robinson & Malhotra, 2005b; Soares et al., 2017). By fostering strong relationships and communicating openly with partners, businesses gain valuable insights to continuously improve their product and service delivery processes.

The emergence of Industry 4.0 (I4.0), first introduced at the Hannover Industrial Fair in Germany in 2011, marks a pivotal moment in the development of technology and its impact on numerous fields. This Fourth Industrial Revolution has combined many fields of knowledge from physics, digital technology, and biology to drive digital transformation in manufacturing and production across various sectors and industries (Kagermann, 2015; X. Xu et al., 2021). Nine key technologies identified by the Boston Consulting Group have become central: Big Data Analytics (BDA), Autonomous Robotics, Simulation, Horizontal and Vertical System Integration, Internet of Things (IoT), Cybersecurity, Cloud Computing, Amortization (AM), and Augmented/Virtual Reality (AR/VR) (M. Akbari et al., 2024; Kagermann, 2015). Advanced Industry 4.0 (I4.0) technologies are indispensable for enhancing supply chain quality management (Amorim et al., 2016). I4.0 technologies enable data analytics, process automation, supply chain optimization, and seamless system integration. For example, IoT supports real-time monitoring, cybersecurity protects data, cloud computing manages information, AM supports prototyping, and AR enriches training activities (Acioli et al., 2021; Hofmann & Rüscher, 2017), highlighting the transformative impact of Industry 4.0 technologies on business performance in supply chain quality management.

Increasingly, research focuses on using indicators to assess the impact of SCQM on business performance in terms of product quality, operational management, and finance. However, there is still a lack of research on the impact of SCQM on the overall performance of a sustainable supply chain. This is the reason for this research topic to further explore SCQM in the Vietnamese FMCG sector. Simultaneously, based on resource theory, the

study also examines the role of Industrial 4.0 in supporting and promoting the impact of SCQM on the operational efficiency of sustainable supply chains in FMCG enterprises.

3.2 Operationalization of Theoretical Constructs

To address research questions related to supply chain quality management in Vietnam's fast-moving consumer goods (FMCG) industry, this study concretizes key concepts through a structured theoretical framework based on existing literature and empirical verification. These concepts include supply chain quality management (SCQM), sustainable supply chain performance (SCSP), and Industry 4.0 (I4.0), each measured using multi-objective scales inherited from previous studies and adapted through the research process in Vietnam.

Overall, SCQM is considered a systems-based approach to improving performance, creating synergy between best practices in supply chain management (SCM) and quality management (QM) to seize potential opportunities created from upstream and downstream relationships with suppliers and customers (Foster & Ogden, 2008). Supply Chain Quality Management 4.0 is a comprehensive and transformative approach to managing both supply chain and quality functions, in which organizations integrate advanced Industry 4.0 technologies into their operations within a network of firms to deliver superior products and services, streamline processes, and strengthen supply chain relationships. This integration aims to achieve high levels of customer satisfaction while generating significant strategic value for all stakeholders involved in the supply chain.

3.2.1 Supply Chain Quality Management

In the context where sustainable development has become one of the strategic priorities for businesses, examining the role of internal practices in relation to sustainable performance holds both theoretical and practical significance.

3.2.1.1 Internal Practices

Within the framework of Supply Chain Quality Management (SCQM), internal practices are seen as critical drivers that ensure not only the quality and resilience of supply chains but also their alignment with sustainability objectives. These practices reflect a firm's managerial and operational capabilities, determining how resources are utilized, processes are optimized, and organizational culture is shaped toward long-term sustainability. This practice included:

- **Top management support:** Consensus and support from leadership are key to maintaining sustainable performance in any organization. By providing resources, expertise, and strategic direction, leadership lays the groundwork for implementing sustainable initiatives. Furthermore, strong commitment from senior management not only affirms the organization's priorities to stakeholders but also contributes to fostering a culture of social and environmental responsibility (Fareed & Su, 2022; Sarkis et al., 2020). This not only engages current employees but also helps the business attract talent who share its values and beliefs about sustainable development. The impact of leadership support on sustainable performance is most evident in the development of environmentally friendly products and services. For these sustainable solutions to be successfully researched and commercialized,

consensus from senior management is a prerequisite. Because developing this product portfolio requires significant investment in Research and Development (R&D), leadership intervention plays a crucial role in prioritizing and allocating the necessary resources to sustain these activities. Ultimately, support from senior leadership plays a crucial role in establishing strategic partnerships with relevant organizations and partners to advance sustainable development goals (Khan et al., 2022). Strong leadership commitment not only strengthens trust but also enhances the company's credibility in the eyes of stakeholders. This is the essential foundation for forming alliances to address complex sustainability challenges in today's context.

- **Human resource and organizational skills – HRM:** Contributes to sustainable performance through various mechanisms (Guerce et al., 2016). First, HRM policies and practices can be used to attract and retain personnel who share the organization's commitment to sustainable development (Renwick et al., 2013). By integrating sustainability into a core value from the recruitment process, HRM clearly demonstrates that it is a top priority for the business. This approach helps organizations attract enthusiastic candidates whose vision aligns with the company's strategic direction (Jabbour et al., 2008). Beyond recruitment, human resource management (HRM) promotes sustainable performance through three strategic pillars. First, by implementing in-depth educational programs, HRM equips employees with the necessary knowledge to integrate green practices into their daily work, thereby fostering a responsible corporate culture. Second, HRM

plays a role in designing standardized policy frameworks and procedures for energy saving, waste reduction, and sustainable supply chain management, ensuring consistency across all operational activities (Dumont et al., 2017). Finally, HRM supports monitoring and reporting results through a system of key performance indicators (KPIs) linked to sustainability goals. Closely monitoring progress not only helps businesses identify areas for improvement but also strengthens their reputation and image of social responsibility with stakeholders (Guerce et al., 2016).

- **Awareness:** Awareness helps businesses identify risks and potential problems related to operations early on. From there, managers can develop strategies to mitigate risks and capitalize on opportunities for growth. Especially in the supply chain, raising awareness through training will encourage employees and suppliers to adopt green practices such as energy saving and waste reduction (Aguinis & Glavas, 2012; Lozano et al., 2013). Transparent communication about sustainability initiatives strengthens credibility and trust. Internal & Customer: Attracting employees and consumers who share the same values. Supply Chain: Fostering collaboration among suppliers to share experiences and jointly develop sustainable solutions. By understanding sustainability issues, organizations are motivated to innovate and develop new products/services that meet ecological standards. This not only enhances competitiveness but also fosters a culture of responsibility throughout the entire supply chain, benefiting both the business and the community. Awareness allows for the integration of environmental and social factors into decision-making processes, rather than focusing solely on economics.

This balance ensures sustainable outcomes and optimizes organizational performance in the long term.

- **IT infrastructure:** IT infrastructure plays a strategic role in optimizing sustainable performance in the supply chain by enabling the monitoring, measurement, and implementation of data-driven solutions (Dao et al., 2011). This technology not only minimizes the carbon footprint by supporting remote work and digitizing processes to eliminate paper waste (Coroama et al., 2012; Dedrick, 2010) but also provides energy monitoring and product lifecycle management (PLM) systems to optimize resource utilization. Furthermore, the IT platform fosters transparency and close collaboration among supply chain partners, ensuring all operations are consistent with environmental standards and the organization's long-term sustainability goals.

3.2.1.2 External Practices:

In parallel with internal practices, external practices also play a particularly important role in enhancing the sustainable performance of enterprises. Within the framework of Supply Chain Quality Management (SCQM) and in the context of Industry 4.0, external practices reflect the extent of engagement, collaboration, and integration between firms and their supply chain partners, including suppliers, customers, and other stakeholders. These practices help extend sustainability values beyond the internal scope of the organization, fostering transparency, driving innovation, and generating synergistic value across the environmental, social, and economic dimensions. Therefore, this study develops hypotheses to clarify the impact of external practices on sustainable performance,

considering them as one of the key pillars for strengthening firms' competitiveness and long-term adaptability. These practices included:

- **Information sharing:** Information sharing plays a crucial role in driving sustainable performance through four core mechanisms: enhanced collaboration, knowledge exchange, transparency, and innovation. Sharing data and initiatives on digital platforms enables stakeholders, especially suppliers, to collaborate on risk identification and the development of integrated green solutions across the entire supply chain (Zhu et al., 2012). This process not only facilitates the exchange of best practices to improve resource efficiency but also helps businesses build credibility and trust with investors and customers through transparent disclosure of sustainable performance. Finally, continuously updating new trends and technologies through a shared information network allows organizations to seize opportunities for breakthrough product development, thereby enhancing competitiveness and long-term profitability.
- **Supply chain integration:** Supply chain integration plays a crucial role in driving sustainable performance by synchronizing links from procurement and production to distribution (Flynn et al., 2010; Wiengarten et al., 2014). This integration process optimizes resources, minimizes waste and operating costs, thereby promoting circular economy practices and improving efficiency (Zhao et al., 2008). Simultaneously, the close connection between components in the chain allows for the synchronized implementation of sustainable solutions such as optimizing transportation routes to reduce emissions and prioritizing environmentally friendly

raw materials (Kouvelis et al., 2006; Seuring & Müller, 2008b). Furthermore, integration enhances interaction and understanding of stakeholder needs, strengthening the reputation and social responsibility of the business (Cao & Zhang, 2011; Vachon & Klassen, 2008). Finally, through extensive collaboration with suppliers who share sustainable values, organizations can mitigate supply risks, ensure responsible sourcing, and build strong customer trust (Gimenez & Tachizawa, 2012; Mani et al., 2018).

Each SCQM category is measured using a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree), with items adapted from all previous research. Confirmatory factor analysis (CFA) will be used to validate the dimensionality and reliability of these scales, ensuring internal consistency (Cronbach's $\alpha > 0.7$) and construct validity ($AVE > 0.5$).

3.2.2 Sustainability Development

The literature consistently stresses that SCQM 4.0 must deliver triple bottom line (TBL) outcomes economic, environmental, and social sustainability.

Economic performance: SCQM 4.0 enhances cost efficiency by optimizing logistics networks, reducing lead times, and leveraging automation. Giusti highlights dynamic logistics networks that balance efficiency with flexibility, while Ding show how expedited systems improve responsiveness (Ding et al., 2021; Giusti et al., 2019). Klumpp argues that automation reduces labor dependency, enabling scalable efficiency. Innovation and agility, supported by Industry 4.0 technologies, further strengthen competitiveness (W. Ahmed et al., 2020; Klumpp et al., 2019).

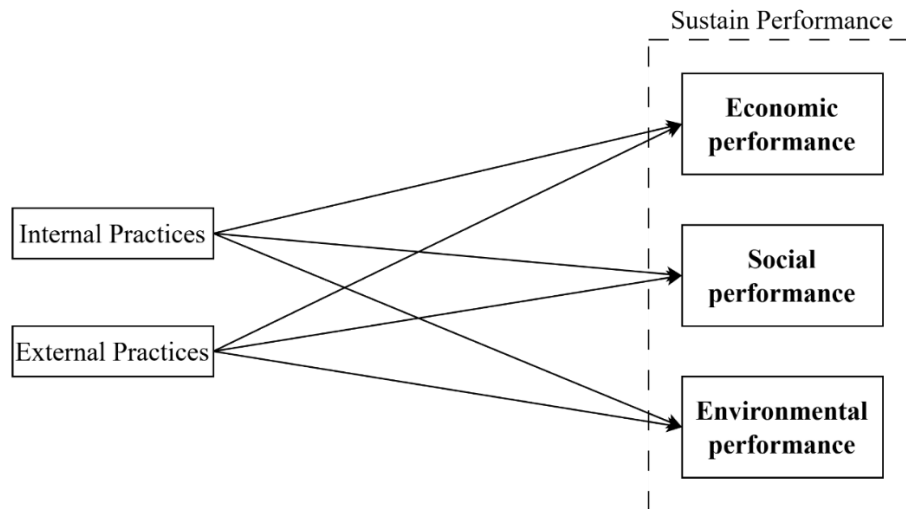
Environmental performance: Environmental sustainability emphasizes reducing natural resource consumption, minimizing emissions, and promoting renewable energy. Baloch showed that SCQM 4.0 reduces energy and material inputs, while Marrucci highlight its role in waste management and recycling (Danish et al., 2019; Marrucci et al., 2020). Manupati demonstrates technological solutions for reducing GHG emissions, and Dantas emphasize energy efficiency. Nunes present renewable integration examples such as solar-powered warehouses and electric delivery fleets.

Social performance: Social sustainability focuses on labor practices, ethics, inclusivity, and community development. Celma stress safe and fair working conditions, while Nayak highlights the elimination of child and forced labor (Celma et al., 2018; Nayak et al., 2019). Gomez-Trujillo link ethical practices and transparency to brand reputation. Petrou emphasizes training and upskill for technological adaptation. Firms adopting SCQM 4.0 are also expected to support diversity, inclusivity, and community initiatives, thereby contributing to equitable growth (Gomez-Trujillo et al., 2020; Petrou et al., 2018; Tate & Warschauer, 2022).

Each SSCP category is measured using a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree), with items adapted from previous research. Confirmatory factor analysis (CFA) will be used to validate the dimensionality and reliability of these scales, ensuring internal consistency (Cronbach's $\alpha > 0.7$) and construct validity ($AVE > 0.5$).

We obtain a proposed research model which includes internal and external measures impacting economic efficiency, social efficiency, and environmental efficiency, as shown in the figure 3.1

Figure 3. 1 Research model for 1st and 2nd RQ



Source: by Author

3.2.3 Industry 4.0 Technologies Adoption

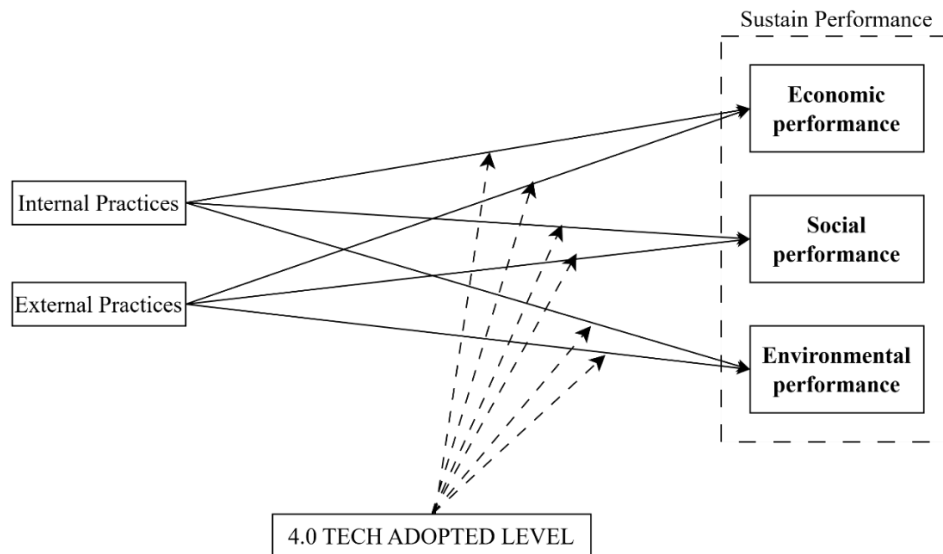
- Robotics
- 3D printing technology
- Cloud technologies
- Block chain technology
- Cyber-Physical Systems (CPS)
- Enterprise Resource Planning (ERP)
- Radio Frequency Identification (RFID)
- Semantic Machine-to-Machine (M2M) Communication
- Internet of Things (IoT)
- Big Data Analytics (BDA)
- Artificial Intelligence (AI)

Previous research indicated that the amalgamation of Supply Chain Quality Management (SCQM) with Industry 4.0 technologies significantly enhances sustainable performance in organizations, thereby augmenting firms' abilities to monitor and regulate the environmental and social impacts of their supply chain operations.

Moderation effects will be tested using interaction terms in structural equation modeling (SEM), allowing for the assessment of how Industry 4.0 Technologies Adoption buffer or amplify the impact of SCQM on sustainability performance outcomes.

The research offered the moderate role of Industrial 4.0 Technology Adoption Level in figure 3.2

Figure 3. 2 Research Model for the 3rd RQ



Source: by Author

3.3 Research Design:

The main purpose of this study is to conduct an in-depth investigation into the nature, measurement, and impact of Supply Chain Quality Management (SCQM) on sustainable performance in Vietnam's fast-moving consumer goods (FMCG) industry. With increasingly fierce competition in the FMCG sector, operational errors are considered a key factor for business survival. Many previous studies have assessed both internal and external factors of SCQM as having a positive impact on the effectiveness of a sustainable supply chain. However, this study also expands to examine the impact of Industry 4.0 aspects on the relationship between SCQM and sustainability performance outcomes.

To achieve the research objectives, the study developed a research process consisting of three stages: Synthesis and scale development; Assessment of the impact of SCQM on products; and Evaluation of the role of Industry 4.0 in the relationship between SCQM and products. This process was implemented over 12 months with five specific steps: theoretical synthesis; scale development; expert interviews; field surveys; and data calculation. The research process utilized a combination of qualitative and quantitative research methods.

In the theoretical synthesis phase, the study briefly reviewed 44 previous research papers on the topic of Supply Chain Quality Management and related sustainability topics. This process helped the author synthesize the measurement aspects of SCQM 4.0, SCP, and Industry 4.0. Based on resource theory and systems theory, the study proposed a list of questions that could answer the study's objectives. Next, the study assessed the suitability of the question list for the Vietnamese FMCG industry through in-depth interviews with

experts in the field of supply chain management, both as sellers and intermediary traders. This process helped refine the survey questions to make them more relatable and understandable to respondents. In the fourth phase, the study will survey respondents currently holding management roles in Vietnamese FMCG companies. The process is expected to collect a minimum of 250 survey responses to support the subsequent research. During the data evaluation phase, the study will utilize software such as Excel, SPSS, and Smart-PLS to assess the collected data, answer the hypotheses formulated, and find solutions to the initial research objectives.

An extensive literature review of supply chain risk factors and supply chain performance measures was identified (Tables 3.1). Then synthesize some factors related to SSCRs, dynamic supply chain risk management practices, Reactive Strategies and Proactive Strategies and then build a survey questionnaire.

Table 3.1 Questionair development results

Group 1. Leadership Commitment & Top Management Support

Variable	Reference
Strategic leadership for technology adoption	(Bastas & Liyanage, 2018b; Kaynak & Hartley, 2008)
Understanding importance of technology implementation	(Bastas & Liyanage, 2018b; Kaynak & Hartley, 2008)
Policy setting for new technology	(Bastas & Liyanage, 2018b)
Resource provision for new technology	(Kaynak & Hartley, 2008)

Variable	Reference
Leadership promotion of technology development	(Bastas & Liyanage, 2018b)
Leadership participation in technology improvement	(Kaynak & Hartley, 2008)
Leadership accountability for technology	
Continuous commitment to technology adoption	(Bastas & Liyanage, 2018b)

Source: by Author

Group 2. Human Resource Development & Employee Involvement

Variable	Reference
Employee development aligned with strategic goals	(Flynn et al., 1994; Jabbour et al., 2008)
Organizational structure for technology adoption	(Zu et al., 2010)
HR strategy supports training and adoption	(Flynn et al., 1994)
Work environment supports learning and adoption	(Zu et al., 2010)
Employee empowerment for new technology	(Flynn et al., 1994)
Motivation for employees to adopt technology	(Zu et al., 2010)
Training needs identified by employees/managers	(Flynn et al., 1994)

Source: by Author

Group 3. Information Technology & Digital Infrastructure

Variable	Reference
IT infrastructure equipped from project start	
IT infrastructure supports new technology	
IT infrastructure supports technological development	(Dubey et al., 2019)
IT infrastructure can handle big data storage	

Source: by Author

Group 4. Employee Readiness & Attitude

Variable	Reference
Employee willingness to adopt technology	(Flynn et al., 1994)
Reward system for adoption	(Zu et al., 2010)
Employee understanding of importance	(Flynn et al., 1994)
Employee awareness of challenges	(Zu et al., 2010)
Employee belief in positive impact	(Flynn et al., 1994)

Source: by Author

Group 5. Supplier Collaboration & Information Sharing

Variable	Reference
Supplier understanding of benefits	(KANNAN, 2005; Robinson & Malhotra, 2005a)
Information sharing with supply chain partners	(Robinson & Malhotra, 2005a)

Variable	Reference
Timely information exchange	(KANNAN, 2005)
Accurate information sharing	(Robinson & Malhotra, 2005a)
Quality-focused communication with partners	(Robinson & Malhotra, 2005a)
Sharing risks and rewards	(KANNAN, 2005)
Supporting partners in quality improvement	(Robinson & Malhotra, 2005a)
Common objectives with partners	(Robinson & Malhotra, 2005a)
Long-term trust relationships	(KANNAN, 2005)

Source: by Author

Group 6. Agility, Flexibility & Responsiveness

Variable	Reference
Efficient resource utilization	(Gligor & Holcomb, 2012)
Adaptability to environmental changes	(Yusuf et al., 2014)
Flexibility to customer requirements	(Gligor & Holcomb, 2012)
Timely response to customer requests	(Yusuf et al., 2014)
Quick reaction to market changes	(Gligor & Holcomb, 2012)

Source: by Author

Group 7. Quality, Supply Chain & IT Systems

Variable	Reference
Established quality management systems	(Kaynak & Hartley, 2008)
Established supply chain management systems	(Robinson & Malhotra, 2005a)

Variable	Reference
Established IT/digital transformation systems	(Dubey et al., 2019)
Integration of quality tools into SCM	(Bastas & Liyanage, 2018b)

Source: by Author

Group 8. Industry 4.0 Technologies Adoption

Variable	Reference
Robotics	Frank et al. (2019); Tortorella & Fettermann (2018)
3D printing	
Nanotechnology	(Frank et al., 2019)
Cloud technologies	
Blockchain	Queiroz et al. (2019)
Cyber-physical systems (CPS)	Frank et al. (2019)
ERP	Frank et al. (2019); Tortorella & Fettermann (2018)
RFID	Frank et al. (2019)
Semantic machine-to-machine	
Business intelligence	
IoT	(Dubey et al., 2019)
Big data analytics	
Artificial intelligence	

Source: by Author

Group 9. Sustainability (Economic, Environmental, Social)

Variable	Reference
Sustainability management systems	
Carbon emission & waste management	
Renewable energy usage	(Carter & Rogers, 2008)
Workplace safety	
Social inclusion and equality	
Faster delivery through smart transport	
Sustainability communication	
Employee engagement in sustainability	
Reduction in energy consumption	
Work changes due to technology	(Beske et al., 2014)
Non-discrimination	
Employee satisfaction	
Dynamic logistics networks	
High flexibility	
Increased automation	(Frank et al., 2019)
Reduction in natural resource usage	
Reputation and community image	(Elkington, 2006)
Business ethics compliance	
Improved information sharing	(Robinson & Malhotra, 2005a)

Source: by Author

3.4 Expert Interview:

In-depth interviews with experts were conducted to verify, review, and make necessary adjustments to the measurement of the research concepts. The initial proposed questionnaire included 38 questions measuring the level of SCQM application; 29 questions measuring the effectiveness of sustainable construction; and 12 questions on technology applications (Appendix 1). Given the length and complexity of the questions, conducting interviews with experts in the field of sustainable supply chain transformation helped to express the concepts in the questions more effectively (the issues addressed were clear and relevant to the actual situation in Vietnam).

Sampling method: In qualitative research, there are no mandatory rules regarding sample size, and as Coyne emphasizes, “the value, significance, and insights generated from a qualitative survey are more related to the informational richness of the selected cases and the researcher’s observation/analytical ability than to the sample size.” Although qualitative research often focuses on information quality over quantity, some methodological researchers warn against underestimating sample size (Coyne, 1997). According to some researchers, the question “how many respondents should be used?” is also important in qualitative research (Onwuegbuzie & Leech, 2007). Onwuegbuzie and Leech summarize a general strategy for sampling in qualitative research: The sample size should be large enough so that the data reaches saturation, the point at which no new information is found through subsequent interviews. However, in fields requiring highly qualified experts, such as technology applications and sustainable supply chain management, selecting a sufficiently large number of experts is extremely difficult. After

considering suggestions from previous researchers, combined with the context of the author's study, the proposed number of experts is 16 (Appendix 2).

The individuals invited to provide feedback on the research topic are listed in Appendix 3. A total of sixteen experts participated in the research, all with many years of direct experience in applying technology to sustainable supply chains in Vietnam. These experts hold leadership roles in their respective FMCG companies and serve key roles in business associations and industrial park infrastructure management. With such high-level expertise, their feedback significantly contributed to the research questionnaire and increased the reliability of the results obtained upon completion.

Given the importance and quality of the expert panel, preparation for the one-on-one interviews was given extra attention. The author sent individual invitations to each expert, emphasizing formality, seriousness, and high confidentiality. Meetings took place in private locations (meeting rooms at business associations, companies, etc.). Invitations were sent to experts one month in advance to allow them time to schedule. Along with the invitations, the author also sent experts a summary of the main points of the research topic, along with articles contributing to the research questionnaire, for their reference before the interviews. The interviews took place throughout 2025. The interview script ensured the core elements of qualitative research: respect for confidentiality; respect for objectivity; and the spirit of scientific research.

After completing the series of expert interviews, the author also sent a thank-you letter and shared the new points and suggestions from the expert group on this topic. Based on the experts' contributions, the main survey questionnaire only retained relevant filtered

information, such as type of business, main customer base of the business (B2B, B2C, or both). This information helps the author evaluate and expand the research in the future. Questions were removed, leaving 53 questions. In addition, the experts also suggested many revisions and suggestions to make the questionnaire more effective; details of the final questionnaire were listed in Appendix 4.

3.5 Population and Sample:

The population for this study comprises professionals working in Vietnam's fast-moving consumer goods industry who are directly involved in supply chain operations and sustainability-related initiatives. These individuals include supply chain managers, operations manager, and other roles that contribute to the strategic and operational management of supply chains. Their practical experience and decision-making authority make them ideal key informants for this research, as they possess firsthand knowledge of how Sustainable Supply Chain Quality Management applied and effected to their Business Performance.

The target sample size for the study is 250 respondents, which is considered appropriate for advanced statistical techniques such as structural evaluation & model evaluation. The sample size also allows for subgroup analysis based on demographic variables, such as job title, years of experience, company size, and product category, which can provide deeper insights into how different organizational contexts influence the research hypothesis.

3.6 Data Collection Procedures

The in-depth interview process was conducted using the Questionnaire presented in appendix 3. Invitations were sent to experts during the period 1st May 2025 to 24th May 2025. The interviews were then conducted at the experts' convenience, according to their schedules, from June to July of 2025. Each interview lasted 30-60 minutes, and permission was obtained for the use of audio recording equipment in the study. The final data was compiled and used for refining the survey scale as shown in the appendix.

The research process involved conducting a survey using Google Forms with a two-part structure: classification questions and main research questions. Due to the respondents being senior executives at FMCG companies, the questionnaire was conducted bilingually in English and Vietnamese to help respondents understand and answer accurately. A 5-point Likert scale was used because it is familiar and easily reflects the respondents' perspectives on aspects of their actual work at the company. The study utilized a pilot study with 30 respondents to assess the level of understanding of the questionnaire and to ensure there were no technical errors in data collection from Google Forms.

3.7 Data Analysis

The data collected through the structured questionnaire will be analyzed using **quantitative statistical techniques** to examine the relationships among SCQM 4.0, SCP, and I4.0 applied. The analysis will be conducted in three main stages: data screening, measurement model validation, and structural model testing.

Data Screening and Preparation

Initial data preparation will involve checking for outliers, missing entries, and distributional normality. Following this, the study will employ descriptive statistics to outline participant demographics. Furthermore, the internal consistency of the measurement scales will be evaluated via Cronbach's alpha, adhering to the threshold of 0.70 recommended by (Hair et al., 2011).

Measurement model evaluation

To refine the measurement scales, reliability analysis was performed using SPSS. We retained only those observed variables exhibiting a Cronbach's Alpha above 0.7 and a Corrected Item-Total Correlation of at least 0.3, discarding any non-compliant items

Variables that passed the initial screening were further analyzed using Exploratory Factor Analysis (EFA). According to Hair this technique is used to determine the underlying structure of a large group of variables. Furthermore, the analysis ensures that the resulting factors maintain their original conceptual value, provided that all necessary EFA assumptions and requirements are strictly satisfied:

The KMO coefficient must be between 0.5 and 1.

The Barlett test coefficient must be less than or equal to 0.05.

The total variance extracted needed to be greater than 50% to ensure that the discovered factors could almost entirely represent the value of the old variable sets.

The Eigen Value coefficient needed to be greater than 1.

The factor loading of each observed variable needed to be greater than 0.5.

Explored factors needed to satisfy both convergent and discriminant validity.

Once the EFA is complete, any necessary restructuring of the dependent variables will be performed. Finally, the study will employ SmartPLS for measurement model evaluation, ensuring all criteria for outer loadings, reliability, and validity (convergent and discriminant) are met.

Structural model assessment

First of all, the PLS Algorithm was conducted to assess the Collinearity Statistics (VIF), the Coefficient of determination (R square) and the effect size (F square). Secondly, the data was bootstrapped to evaluate the path coefficient and test hypotheses.

The study assesses multicollinearity using VIF coefficients, as recommended by Hair to prevent decreased estimation precision caused by inflated standard errors. A VIF value above 5 represents a high risk of multicollinearity, and values ranging from 3 to 5 indicate moderate concern. Ideally, VIF coefficients should remain below 3 to ensure the absence of multicollinearity issues (Hair et al., 2011).

Secondly, Henseler stated that researchers could measure R square to evaluate the Coefficient of determination (Henseler et al., 2015). According to Henseler, the R square represented the proportion that the independent variables could explain the variance of the dependent variables (Henseler et al., 2009).

Thirdly, the f-square effect size was analyzed to determine the strength of the relationship between independent and dependent variables. Following Cohen conventions, an f-square value below 0.02 indicates a negligible effect. Values ranging from 0.02 to 0.15 suggest a small effect, while those between 0.15 and 0.35 represent a medium effect. Finally, an f-square exceeding 0.35 signifies a substantial or large impact

Additionally, the data was bootstrapped with the SmartPLS tool to evaluate the path coefficient and test hypotheses. According to Hair, the path coefficient and hypotheses were assessed based on two primary index columns consisting of the Original sample and p-values columns. Specifically, a hypothesis was adopted if its p-value did not exceed 0.05. Then, the interaction between the independent, intermediate, and dependent variables was concluded based on the accepted hypotheses.

3.8 Conclusion

This chapter develops and proposes a research process focused on the collaboration between SCQM 4.0 and the sustainable development effectiveness of Vietnamese FMCG enterprises. Furthermore, with the ambition to explore the role of the 4.0 technology application trend in supply chain management, the study also proposes the development of various aspects for research and analysis. Chapter 3 also proposes standard response services for data collection and tools that can be used to calculate collected data. Statistical data is also proposed in Chapter 3 to evaluate the measurement scale and structural model of the research.

CHAPTER IV: RESULTS

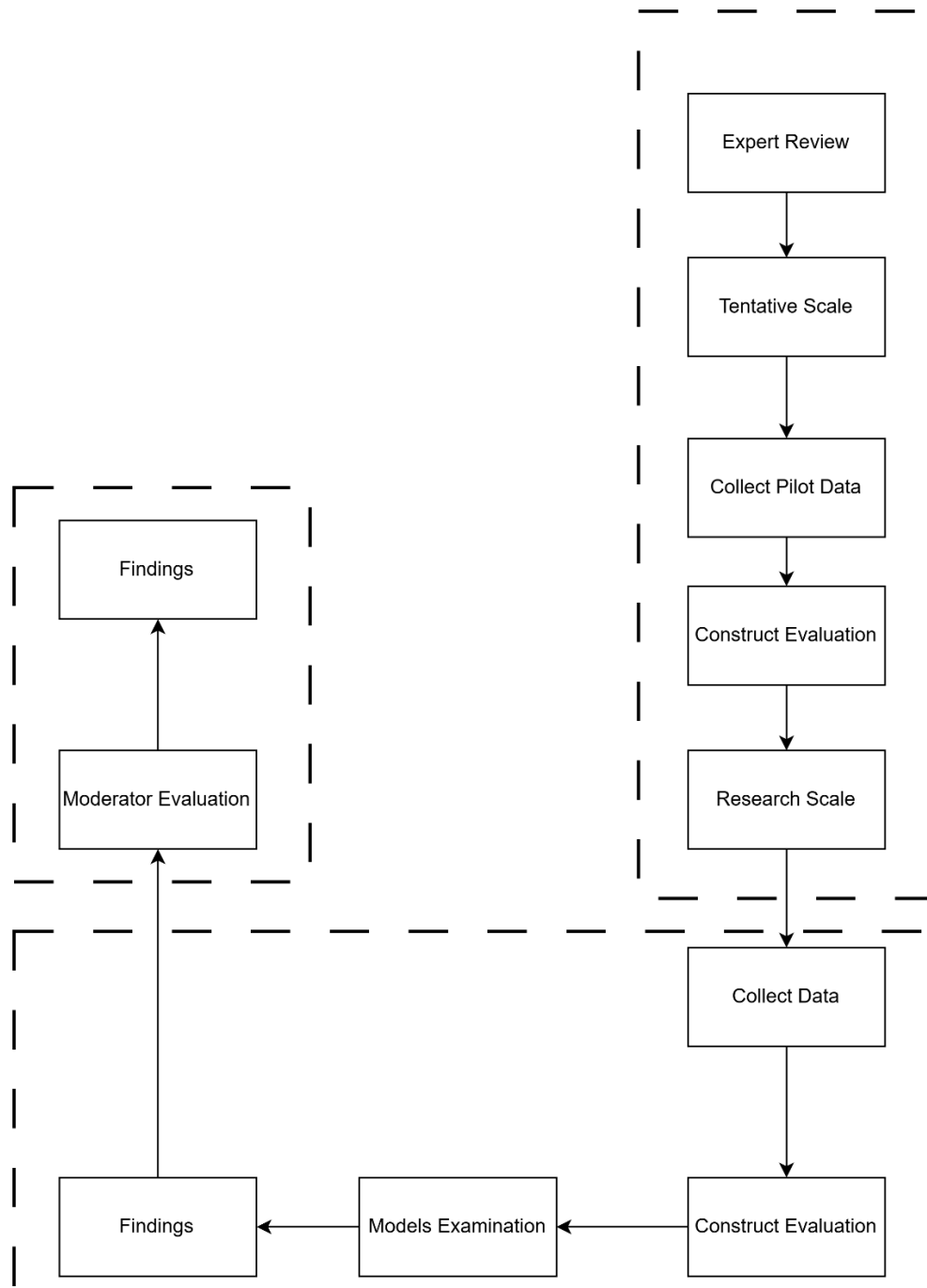
There are three primary sections in Chapter 4. The preliminary study and interview results are presented in the first section. The author makes several modifications to raise the caliber of the research scales in light of these findings. The evaluation and findings from the formal quantitative investigation are presented in the second section. Descriptive statistics are specifically used to characterize the characteristics of observed variables and demographic data. The findings from the Cronbach's alpha test, Exploratory Factor Analysis, measurement model evaluation, and structural model assessment are also included in this section. On the first stage, the research examined the effect of SCQM to each type of Sustainability Development. Next, we checked the moderator effect of 4.0 Technology Innovation to these relationships.

The research process was conducted in three steps:

1. Expert consultation and development of a complete measurement scale
2. Assessment of the impact of Practices on sustainable effectiveness
3. Assessment of the moderating role of the level of application of Industry 4.0 technology

The specific tasks performed in each stage are shown in Figure 4.1

Figure 4. 1 Research process by 3 steps



Source: by Author

4.1 Expert Interview and complete measurement scale:

A team of sixteen experts was selected and sent a work schedule from May 2025 to August 2025. Meetings were held in private to ensure a natural exchange of information and confidentiality. Each interview lasted 30-60 minutes and was recorded (with permission). The collected data was encrypted, with key information revolving around the thematic groups in Table 4.1.

Table 4. 1 Overall Expert Interview Results

Internal Practices			
Key word	Agreed	Eliminated	Adjusted
Top Management Support	16		
Human Resources and Organization Skills	15		1
IT Infrastructure	16		
Technology Value Awareness	16		
External Practices			
Key word	Agreed	Eliminated	Adjusted
Information Sharing	16		
Supply Chain Integration Level	16		
Sustainable Development			
Key word	Agreed	Eliminated	Adjusted
Economic performance	15		1
Social performance	16		
Environmental performance	15		1

Source: by Author

The meaning of the questions was discussed, commented on, and revised into Vietnamese by the expert group. This made the questions more relevant and accurate within the Vietnamese FMCG sector. In addition, questions about the type of business and job titles of respondents were also filtered and removed, retaining only the aspects of: business type and target customers. Experts predict that these two aspects may differ in terms of the impact of practices on the sustainable development of the supply chain.

4.2 Impact Assessment

Following expert interviews, the study converted the questionnaire into Google Forms for convenient distribution to respondents for the research. The pilot survey was conducted with 30 colleagues in the supply chain field. Within three days, the study identified errors in data collection from Google Forms; typing errors in the questionnaire; and display errors that could affect respondents' responses. The pilot data was also entered into SPSS for preliminary Cronbach's Alpha assessment. The results showed that the scale had acceptable reliability.

Starting from September 2025, the study began collecting real-world data from pre-selected respondents. The responses were collected throughout November 2025, resulting in a total of 251 questionnaires. Of these, 250 were valid, while the remaining data were corrupted due to interruptions in the respondents' responses. The collected data was entered into Excel, cleaned, and coded according to the categories shown in Table 4.2 below. Selected responses were coded and separated for later use in the evaluation process.

Table 4. 2 Name and coding data for Supply Chain Quality Management Practices

Coding	Name
TMS1	Top management support
TMS2	
TMS3	
TMS4	
TMS5	
HR1	Human Resources
HR2	
HR3	
HR4	
HR5	
IT1	Information Technology
IT2	
IT3	
AW1	Technology Awareness
AW2	
AW3	
AW4	
AW5	
IS1	Information Sharing
IS2	
IS3	
IS4	
CP1	Supply chain integration
CP2	
CP3	

CP4
CP5
CP6
CP7
CP8
CP9
CP10
CP11
CP12
CP13
CP14
CP15
CP16

Source: by Author

In additional, the SCP factor was developed into four groups: Overall development effectiveness; Economic effectiveness; Social effectiveness; and Environmental effectiveness. The questions were coded by the expert team into a catalog of symbols, which is presented in Table 4.3. Finally, the expert team also provided suggestions to improve the questionnaire for evaluating the aspects of the I4.0 adoption factor.

Table 4. 3 Name and coding data for Sustainability Supply Chain Development and Industriad 4.0 Technology Application

Coding	Name
OA1	Overall Development Performance
OA2	
OA3	
OA4	
EVP1	Environmental Development Performance
EVP2	
EVP3	
EVP4	
EVP5	
EVP6	
SP1	Social Development Performance
SP2	
SP3	
SP4	
SP5	
SP6	
SP7	
SP8	
SP9	
SP10	
EP1	Economy Development Performance
EP2	
EP3	
EP4	

EP5	
EP6	
EP7	
EP8	
EP9	
ITA1	Industrial 4,0 Technology Adoption
ITA2	
ITA3	
ITA4	
ITA5	
ITA6	
ITA7	
ITA8	
ITA9	
ITA10	
ITA11	
ITA12	

Source: by Author

The results of the Cronbach's Alpha analysis for the data, conducted using SPSS version 23, are shown in Appendix 5 with results consistent with Hair. Furthermore, the component questions also had Cronbach's Alpha values greater than 0.3.

The study continued with the exploratory factor analysis (EFA) step to group the questions and further understand the model. The results of the first EFA analysis, including

the KMO, Bartlett test, Eigenvalue and Total Variance Explained, are shown in Table 4.4.

All test values met the requirements. For detail information, please check the Appendix 6

Table 4. 4 1st EFA Result

EFA 1st	
KMO	0,954
sig Bartlett's Test	0,000
Eigenvalue	1,008
Total Variance Explained	66,999%

Source: by Author

In the first EFA analysis, the following questions were removed: HR1; HR2; IS2; IS3; IS4; CP6; CP14; and CP16. This was due to the Factor Loading coefficients of these observed variables being <0.5 or having load factors on two groups simultaneously (CP14).

Next, the study proceeded to remove inappropriate questions and run the EFA a second time to further narrow down the groups in the research model. This process eliminated the question: CP15 when the loading coefficients were found in two groups. The remaining statistical indicators shown in Table 4.5 all met the requirements.

Table 4. 5 2nd EFA Result

EFA 2st	
KMO	0,951
sig Bartlett's Test	0,000
Eigenvalue	1,028
Total Variance Explained	66,723%

Source: by Author

Finally, the study conducted a third EFA run, yielding the results shown in Figure 4.6, with all statistical indicators being perfect. The observed variables regarding Supply Chain Quality Management Practices were grouped into four categories in Table 4.7.

Table 4. 6 3rd EFA Result

EFA 3rd	
KMO	,951
sig Bartlett's Test	0,000
Eigenvalue	1,009
Total Variance Explained	66,840

Source: by Author

Table 4. 7 Grouped and re-named SCQMs

Coded	Name
SS1	Sustainable Quality Management Strategy
SS2	
SS3	
SS4	
SS5	
SS6	
SS7	
SS8	
IT1	Information Technology
IT2	
IT3	
CR1	Company Readiness
CR2	
CR3	

CR4	
CR5	
CR6	
CR7	
CR8	
CR9	
CR10	
CR11	
CR12	
CP8	Supply Chain Integration
CP9	
CP10	
CP11	
CP12	
CP13	

Source: by Author

Sustainable Quality Management Strategy: A sustainable quality management strategy is a concept used in many fields. It emphasizes the role of company leadership; stakeholders (employees, partners, etc.) and the tools used, according to (Siems et al., 2023). For this topic, the expert group emphasized the role of company leadership in understanding the value and knowing how to operate quality management technologies in sustainable supply chain management. In addition, Siems also emphasized the role of other stakeholders in applying technology to sustainably manage supply chain quality.

Information Technology: In this study, we address the information sharing infrastructure aspect within the supply chain. This includes existing technologies that a company can equip itself with to increase operational efficiency. This technological aspect is constantly changing, so from the perspective of this research topic, we only consider it over a short period within which the company's resources can be allocated.

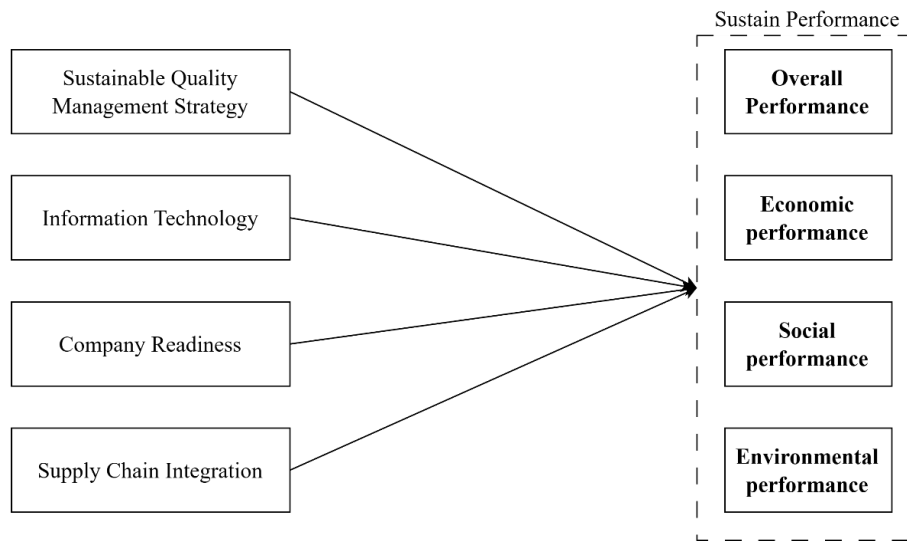
Company Readiness: Manufacturing companies, especially those from developing countries, face gaps in digital technology, an integral part of Industry 4.0. Therefore, they need access to the necessary infrastructure and know-how through technology transfer, contracting with research centers, employee training, and investment in internal research and development to overcome the technical challenges arising from updating existing systems (Birkel et al., 2019; Da Silva et al., 2020). A crucial step on the digital transformation path of manufacturing companies is identifying their current position in relation to Industry 4.0 concepts and then developing a comprehensive transformation plan to implement these concepts (Schumacher et al., 2016). Therefore, the use of readiness or maturity assessment models is recommended (Proença & Borbinha, 2016) to guide companies and their stakeholders in the transition phase effectively and scientifically. Maturity and readiness are used interchangeably in many cases to describe assessment models. However, for this study, we use the term readiness to refer to “the state in which an organization is ready to accomplish a task” (Pacchini et al., 2019) as opposed to maturity, which denotes “the degree of evolution an organization has achieved in relation to a task”. Therefore, readiness differs from maturity due to the perspective that readiness is assessed before engaging in maturation processes, while maturity is assessed from the

actual implementation onward. For a quality management system, readiness for technology integration is what the company and stakeholders assessed before the SCQM implementation process took place. It reflects the preparation and readiness of stakeholders for the FMCG supply chain.

Supply Chain Integration: Assessed through the ability to integrate technologies, tools, and strategies to manage supply chain quality in a sustainable manner.

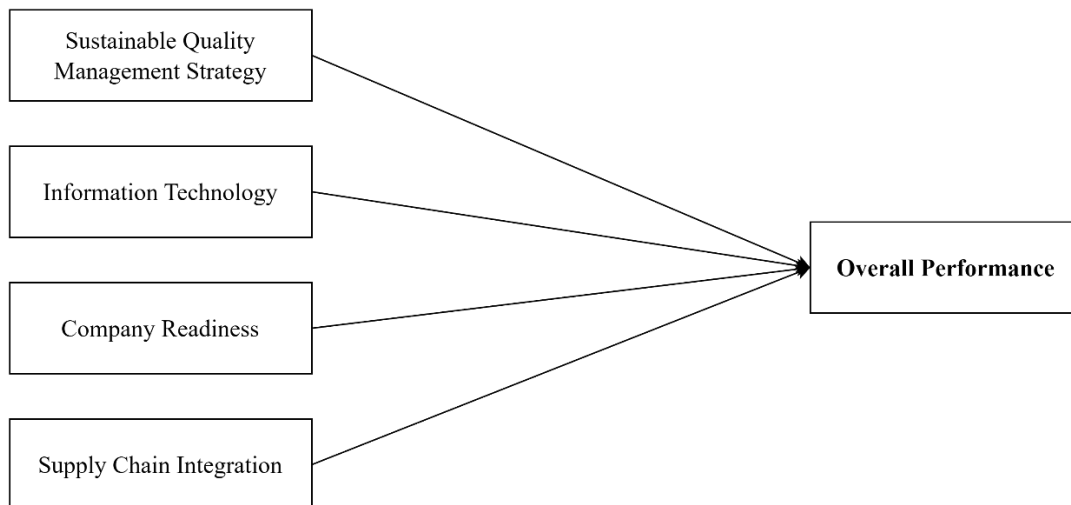
The final results were uploaded to the Smart PLS 3.0 system to assess the impact of Supply Chain Quality Management Practices (SCQM) on Sustainability Developed Performance (SDP) in Vietnamese FMCG enterprises (Appendix 7). This process was carried out by sequentially verifying the impact of SCQM on each aspect of SDP evaluation. Specifically, the study examined the impact of SCQM on the overall SDP aspect of the enterprise; Overall Performance; the Economic Performance aspect; the Social Performance aspect; and the Environmental Performance aspect. We will have research models 1, 2, 3, 4, and 5 listed in Figures 4.2, 4.3, 4.4, 4.5, and 4.6 below.

Figure 4. 2 The 1st SEM Model



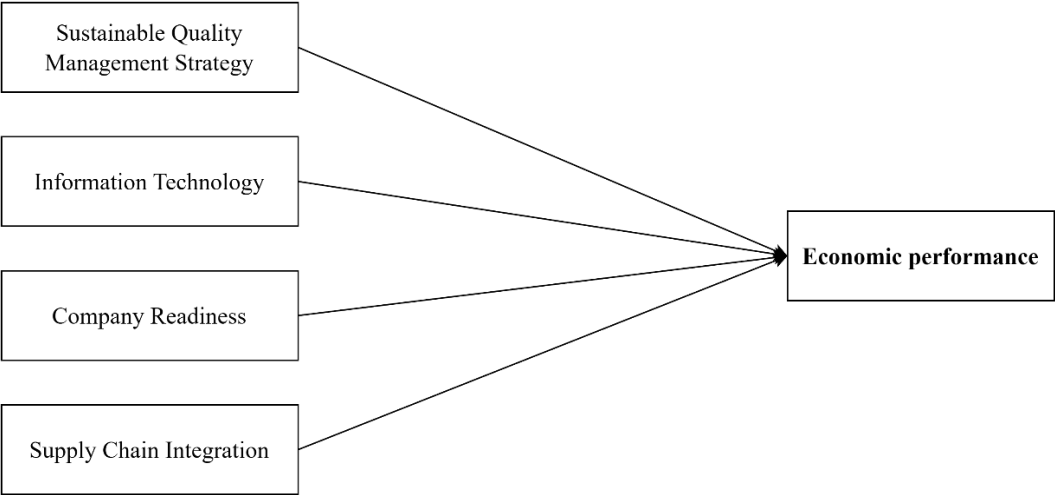
Source: by Author

Figure 4. 3 The 2nd SEM Model



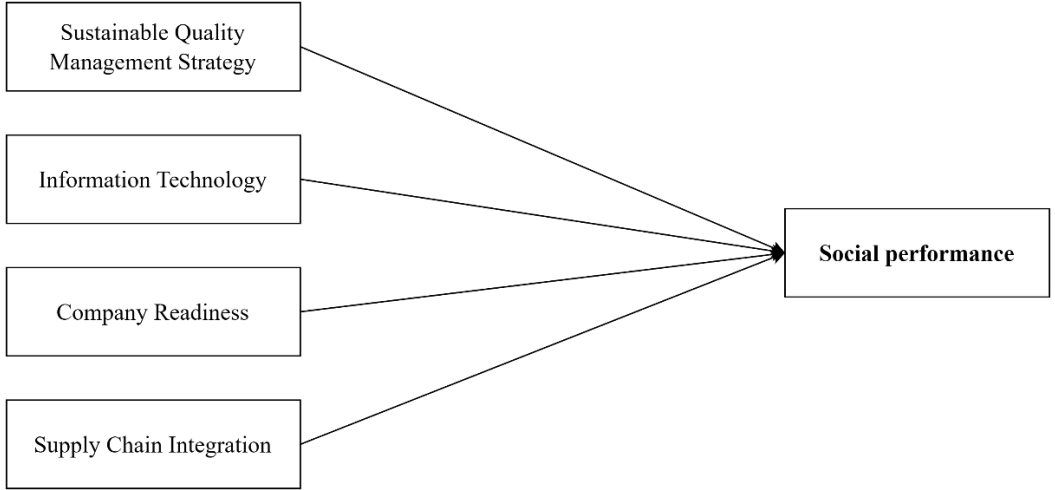
Source: by Author

Figure 4. 4 The 3rd SEM Model



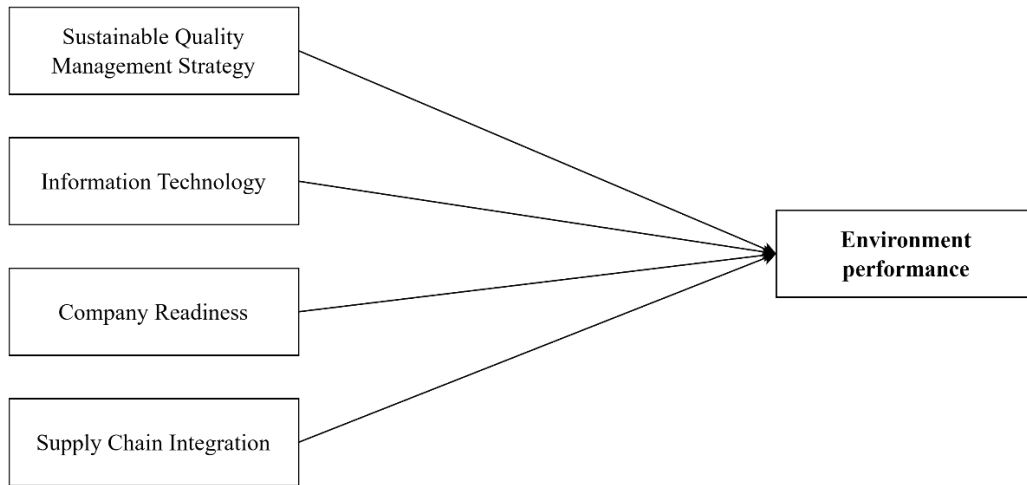
Source: by Author

Figure 4. 5 The 4th SEM Model



Source: by Author

Figure 4. 6 The 5th SEM Model



Source: by Author

The evaluation results from the Smart PLS software show that the SCQM groups all have an impact on the various aspects of the SDP. The results are shown in the R-square table in Table 4.8. Depending on the SDP evaluation model, the roles of the SCQM are changed accordingly.

Table 4. 8 R-Square result of all SEM Model

Model	R Square
1st Model – SCQM – SDP	0,62
2nd Model – SCQM – OA	0,42
3rd Model – SCQM – EP	0,53
4th Model – SCQM – SP	0,59
5th Model – SCQM – EVP	0,51

Source: by Author

Model 1: Assessing the factors SCQM impacting the overall SDP

The Smart PLS analysis results show that the overall model has appropriate statistical indicators. Specifically, Table 4.9 shows that the reliability indicators of the scale all meet the requirements (the AVE of SDP is 0.485, but the remaining indicators are still appropriate and therefore accepted in the model).

Table 4. 9 Construct Reliability and Validity of 1st Model

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
CP	0,921	0,923	0,938	0,717
CR	0,939	0,940	0,947	0,598
IT	0,841	0,850	0,904	0,759
SDP	0,961	0,965	0,964	0,485
SS	0,924	0,925	0,938	0,653

Source: by Author

The results of the Discriminant Validity analysis also provided data with values consistent with quantitative requirements. The information is presented in Table 4.10.

Table 4. 10 1st Model's Discriminant Validity

	CP	CR	IT	SDP	SS
CP	0,847				
CR	0,799	0,773			
IT	0,728	0,732	0,871		
SDP	0,756	0,716	0,669	0,697	
SS	0,751	0,746	0,674	0,664	0,808

Source: by Author

The results of the regression impact analysis are shown in Table 4.11, with the F-Square results displayed inside. To assess the actual impact, a Bootstrapping analysis was conducted with a 5,000-fold coefficient. The analysis results show that the Path Coefficients in Figure 4.12 of the SCQM factors affecting SDP are: CP (beta = 0.399; p = 0.000); CR (beta = 0.202; p = 0.009); and IT (beta = 0.159; p = 0.012). These are the factors that have a positive impact on SDP in the first model. The remaining factor, SS (beta = 0.107; p = 0.125), has no impact on SDP.

Table 4. 11 1st Model's F-Square result

	SDP
CP	0,120
CR	0,031
IT	0,026
SDP	
SS	0,011

Source: by Author

Table 4. 12 1st Model's Bootstrapping Result

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
CP -> SDP	0,399	0,399	0,073	5,491	0,000
CR -> SDP	0,202	0,205	0,078	2,598	0,009
IT -> SDP	0,159	0,155	0,063	2,509	0,012
SS -> SDP	0,107	0,110	0,070	1,533	0,125

Source: by Author

Model 2: Assessing the factors SCQM affecting to the OA of a business

The Smart PLS analysis results show that the overall model has appropriate statistical indicators. Specifically, Table 4.13 shows that the reliability indicators of the scale all meet the requirements.

Table 4. 13 Construct Reliability and Validity of 2nd Model

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
CP	0,921	0,926	0,938	0,717
CR	0,939	0,940	0,947	0,598
IT	0,841	0,855	0,904	0,758
OA	0,868	0,869	0,911	0,719
SS	0,924	0,927	0,938	0,653

Source: by Author

The results of the Discriminant Validity analysis also provided data with values consistent with quantitative requirements. The information is presented in Table 4.14.

Table 4. 14 2nd Model's Discriminant Validity

	CP	CR	IT	OA	SS
CP	0,847				
CR	0,799	0,773			
IT	0,731	0,733	0,871		
OA	0,615	0,581	0,562	0,848	
SS	0,749	0,743	0,671	0,520	0,808

Source: by Author

The results of the regression impact analysis are shown in Table 4.15, with the F-Square results displayed inside. To assess the actual impact, a Bootstrapping analysis was conducted with a 5,000-fold coefficient. The analysis results show that the Path Coefficients in Figure 4.16 of the SCQM factors affecting OA are: CP (beta = 0.331; p = 0.001); and IT (beta = 0.182; p = 0.004). These are the factors that have a positive impact on SDP in the first model. The remaining factors, SS (beta = 0.031; p = 0.731); and CR (beta = 0.161; p = 0.072), have no impact on SDP.

Table 4. 15 1st Model's F-Square result

	OA
CP	0,053
CR	0,013
IT	0,022
OA	
SS	0,001

Source: by Author

Table 4. 16 2nd Model's Bootstrapping Result

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
CP -> OA	0,331	0,328	0,102	3,254	0,001
CR -> OA	0,161	0,166	0,090	1,797	0,072
IT -> OA	0,182	0,174	0,088	2,054	0,040
SS -> OA	0,031	0,040	0,090	0,344	0,731

Source: by Author

Model 3: Assessing the factors SCQM affecting to Economic Performance

The Smart PLS analysis results show that the overall model has appropriate statistical indicators. Specifically, Table 4.17 shows that the reliability indicators of the scale all meet the requirements.

Table 4. 17 Construct Reliability and Validity of 3rd Model

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
CP	0,921	0,922	0,938	0,718
CR	0,939	0,940	0,947	0,598
EP	0,896	0,911	0,916	0,555
IT	0,841	0,845	0,905	0,760
SS	0,924	0,924	0,938	0,653

Source: by Author

The results of the Discriminant Validity analysis also provided data with values consistent with quantitative requirements. The information is presented in Table 4.18.

Table 4. 18 3rd Model's Discriminant Validity

	CP	CR	EP	IT	SS
CP	0,847				
CR	0,798	0,773			
EP	0,704	0,630	0,745		
IT	0,726	0,730	0,600	0,872	
SS	0,751	0,746	0,620	0,674	0,808

Source: by Author

The results of the regression impact analysis are shown in Table 4.19, with the F-Square results displayed inside. To assess the actual impact, a Bootstrapping analysis was conducted with a 5,000-fold coefficient. The analysis results show that the Path Coefficients in Figure 4.20 of the SCQM factors affecting EP are only CP (beta = 0.442; p = 0.000). The remaining factors, CR (beta = 0.076; p = 0.435); IT (beta = 0.124; p = 0.158); and SS (beta = 0.148; p = 0.092), have no impact on EP.

Table 4. 19 3rd Model's F-Square result

	EP
CP	0,118
CR	0,003
EP	
OA	0,013
SS	0,017

Source: by Author

Table 4. 20 3rd Model's Bootstrapping Result

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
CP -> EP	0,442	0,442	0,091	4,839	0,000
CR -> EP	0,076	0,080	0,097	0,781	0,435
IT -> EP	0,124	0,126	0,088	1,411	0,158
SS -> EP	0,148	0,147	0,088	1,683	0,092

Source: by Author

Model 4: Assessing the factors SCQM affecting to Social Performance

The Smart PLS analysis results show that the overall model has appropriate statistical indicators. Specifically, Table 4.21 shows that the reliability indicators of the scale all meet the requirements.

Table 4. 21 Construct Reliability and Validity of 4th Model

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
CP	0,921	0,923	0,938	0,717
CR	0,939	0,940	0,947	0,598
IT	0,841	0,855	0,904	0,759
SP	0,916	0,923	0,930	0,571
SS	0,924	0,927	0,937	0,653

Source: by Author

The results of the Discriminant Validity analysis also provided data with values consistent with quantitative requirements. The information is presented in Table 4.22.

Table 4. 22 4th Model's Discriminant Validity

	CP	CR	IT	SP	SS
CP	0,847				
CR	0,800	0,773			
IT	0,728	0,731	0,871		
SP	0,723	0,715	0,628	0,755	
SS	0,752	0,746	0,675	0,664	0,808

Source: by Author

The results of the regression impact analysis are shown in Table 4.23, with the F-Square results displayed inside. To assess the actual impact level, a Bootstrapping analysis was conducted with a 5,000-fold coefficient. The analysis results show that the Path Coefficients in Figure 4.24 of the SCQM factors affecting the product include: CP (beta = 0.316; p = 0.000); CR (beta = 0.283; p = 0.002); and SS (beta = 0.159; p = 0.029). The remaining factor, IT (beta = 0.083; p = 0.279), has no impact on the product of Vietnamese FMCG companies.

Table 4. 23 4th Model's F-Square result

	SP
CP	0,069
CR	0,056
EP	0,007
SP	
SS	0,022

Source: by Author

Table 4. 24 4th Model's Bootstrapping Result

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
CP -> SP	0,316	0,313	0,079	3,994	0,000
CR -> SP	0,283	0,290	0,090	3,129	0,002
IT -> SP	0,083	0,081	0,077	1,083	0,279
SS -> SP	0,159	0,160	0,073	2,186	0,029

Source: by Author

Model 5: Assessing the factors SCQM affecting to the Environmental Performance

The Smart PLS analysis results show that the overall model has appropriate statistical indicators. Specifically, Table 4.25 shows that the reliability indicators of the scale all meet the requirements.

Table 4. 25 Construct Reliability and Validity of 5th Model

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
CP	0,921	0,926	0,938	0,717
CR	0,939	0,940	0,947	0,598
EVP	0,851	0,869	0,889	0,575
IT	0,841	0,849	0,904	0,759
SS	0,924	0,924	0,938	0,653

Source: by Author

The results of the Discriminant Validity analysis also provided data with values consistent with quantitative requirements. The information is presented in Table 4.26.

Table 4. 26 5th Model's Discriminant Validity

	CP	CR	EVP	IT	SS
CP	0,847				
CR	0,799	0,773			
EVP	0,675	0,642	0,758		
IT	0,730	0,733	0,637	0,871	
SS	0,749	0,746	0,553	0,674	0,808

Source: by Author

The results of the regression impact analysis are shown in Table 4.27, with the F-Square results displayed inside. To assess the actual impact, a Bootstrapping analysis was conducted with a 5,000-fold coefficient. The analysis results show that the Path Coefficients in Figure 4.28 of the SCQM factors affecting EVP include: CP (beta = 0.360; p = 0.000); IT (beta = 0.256; p = 0.003); and CR (beta = 0.188; p = 0.050). The remaining factor, SS (beta = -0.030; p = 0.765), has no impact on the EVP of Vietnamese FMCG companies.

Table 4. 27 5th Model's F-Square result

	EVP
CP	0,076
CR	0,021
EVP	
SP	0,053
SS	0,001

Source: by Author

Table 4. 28 5th Model's Bootstrapping Result

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
CP -> EVP	0,360	0,354	0,099	3,640	0,000
CR -> EVP	0,188	0,195	0,096	1,964	0,050
IT -> EVP	0,256	0,244	0,087	2,943	0,003
SS -> EVP	-0,030	-0,013	0,099	0,298	0,765

Source: by Author

Summarize the Path Coefficients of all five test models:

We have the summary shown in Table 4.29. Specifically, the CP factors of SCQM have a completely positive impact on SDP and each internal aspect of SDP. Regardless of whether we assess the overall effectiveness of sustainable development or each internal component, supply chain integration still plays a positive role in increasing the sustainable effectiveness of Vietnamese FMCG businesses.

The remaining SCQM groups, depending on the specific aspect of the SDP, may or may not impact the increase in sustainable development effectiveness. Specifically, the CR group. Company readiness for technology and supply chain quality management has a positive impact on overall SDP growth; the Social Development aspect; and the Environmental Development aspect.

Meanwhile, the IT – Information Technology Infrastructure group impacts SDP; the overall aspect and growth environment of Vietnamese FMCG businesses. The collected data shows that IT has no impact on economic and social performance.

Ultimately, the SS factors the sustainable quality management strategy of Vietnamese FMCG businesses only have a positive impact on the social development aspect.

Table 4. 29 Total Path Coefficients in 1st and 2nd Research Question

	Original Sample (O)	P Values
CP -> SDP	0,399	0,000
CP -> OA	0,331	0,001
CP -> EP	0,442	0,000
CP -> SP	0,316	0,000
CP -> EVP	0,360	0,000
CR -> SDP	0,202	0,009
CR -> OA	0,161	0,072
CR -> EP	0,076	0,435
CR -> SP	0,283	0,002
CR -> EVP	0,188	0,050
IT -> SDP	0,159	0,012
IT -> OA	0,182	0,040
IT -> EP	0,124	0,158
IT -> SP	0,083	0,279
IT -> EVP	0,256	0,003
SS -> SDP	0,107	0,125
SS -> OA	0,031	0,731
SS -> EP	0,148	0,092
SS -> SP	0,159	0,029
SS -> EVP	-0,030	0,765

Source: by Author

4.3 Moderation Analysis of Industrial 4.0 Technology Adoption

This study assesses the moderating role of Industrial 4.0 Technology Adoption in the relationship between SCQM and SDP. Section 4.2 shows the multifaceted impact of SCQM on various aspects of SDP. Therefore, to gain a comprehensive understanding of the moderating role of I4.0, the study conducted a verification across all five research models (Appendix 8)

Similar to presentation 4.2, this study also assesses the reliability of the I4.0 scale through the Cronbach's Alpha test. The results are shown in the appendix 5, with the Cronbach's Alpha indices fully meeting the requirements of Hair.

This study incorporates the ITA 4.0 group into a SEM structural model to assess the moderating role of this group of factors in the relationship between SCQM 4.0 and SDP. Specifically, the assessments are presented according to each observed aspect of SDP, including: Model 1 all aspects of SDP; Model 2 General observations on Sustainable Supply Chain Development; Model 3 Economic efficiency; Model 4 Social efficiency; and Model 5 Environmental efficiency. The R-Square assessment data shown in Table 4.30 below demonstrates the stability of the data.

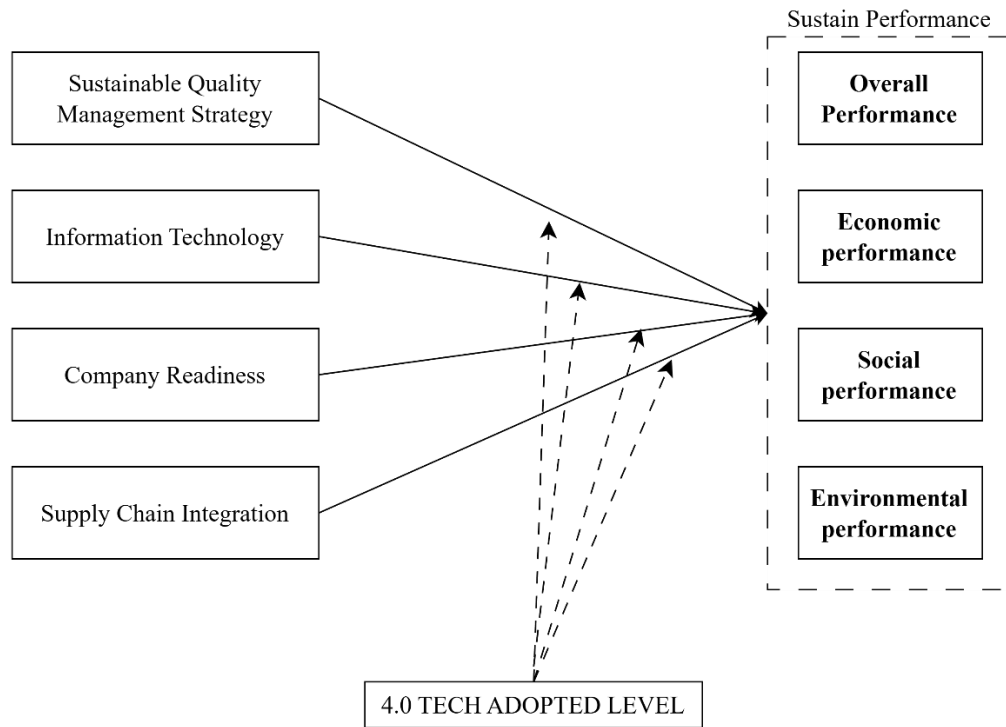
Table 4. 30 R Square of 5 Research Model with Moderator effect of ITA

	R Square
1st Model - SDP	0,69
2nd Model - OA	0,51
3rd Model - EP	0,61
4th Model - SP	0,63
5th Model - EVP	0,58

Source: by Author

Model 1 – All aspects of SDP:

Figure 4. 7 The 1st Model with Moderator effect of ITA 4.0



Source: by Author

Data analysis on Smart PLS shows the model's reliability level as in Table 4.31. The data indicates that the ITA – Industrial 4.0 Technology Adoption factor has stable reliability. However, the study also removed questions about ITA that did not meet the Outer Loading requirements to ensure the AVE index. Specifically, the removed aspects include: ITA2; ITA3; ITA4; ITA6; ITA7; ITA8; and ITA9 (see appendix 8).

Table 4. 31 Construct Reliability and Validity of 1st Model

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
CP	0,921	0,923	0,938	0,717
CR	0,939	0,940	0,947	0,598
IT	0,841	0,851	0,904	0,759
ITA	0,841	0,849	0,894	0,680
Moderating Effect CP	1,000	1,000	1,000	1,000
Moderating Effect CR	1,000	1,000	1,000	1,000
Moderating Effect IT	1,000	1,000	1,000	1,000
Moderating Effect SS	1,000	1,000	1,000	1,000
SDP	0,960	0,963	0,963	0,506
SS	0,924	0,925	0,938	0,653

Source: by Author

The results of the Discriminant Validity analysis also provided data with values consistent with quantitative requirements. The information is presented in Appendix 8. The F-square analysis results in Table 4.32 show the potential to assess the moderating effect of ITA on the relationship between CP and SDP. There is a positive impact of ITA on the SDP of Vietnamese FMCG companies. In addition, the moderating role of ITA on the relationship between CP and SDP is also observed (F-square = 0.025). The study then conducted a Bootstrapping analysis to re-verify this moderating role. The results were as predicted: ITA has a positive moderating effect on the relationship between CP and SDP. Specifically, the data are shown in Table 4.32.

Table 4. 32 1st Model's F-Square result

	SDP
CP	0,039
CR	0,020
IT	0,008
ITA	0,189
Moderating Effect CP	0,025
Moderating Effect CR	0,011
Moderating Effect IT	0,000
Moderating Effect SS	0,001
SDP	
SS	0,026

Source: by Author

Bootstrapping data analysis of model 1 in Table 4.33 shows the moderating impact of ITA on the relationship between CP and SDP. Specifically, the moderating index is inversely related to CP and SDP. This result reflects the competition between the technological element of ITA 4.0 and the existing integration of sustainable supply chains in Vietnamese FMCG businesses. This reflects a mindset of replacing technology rather than upgrading existing supply chain integration.

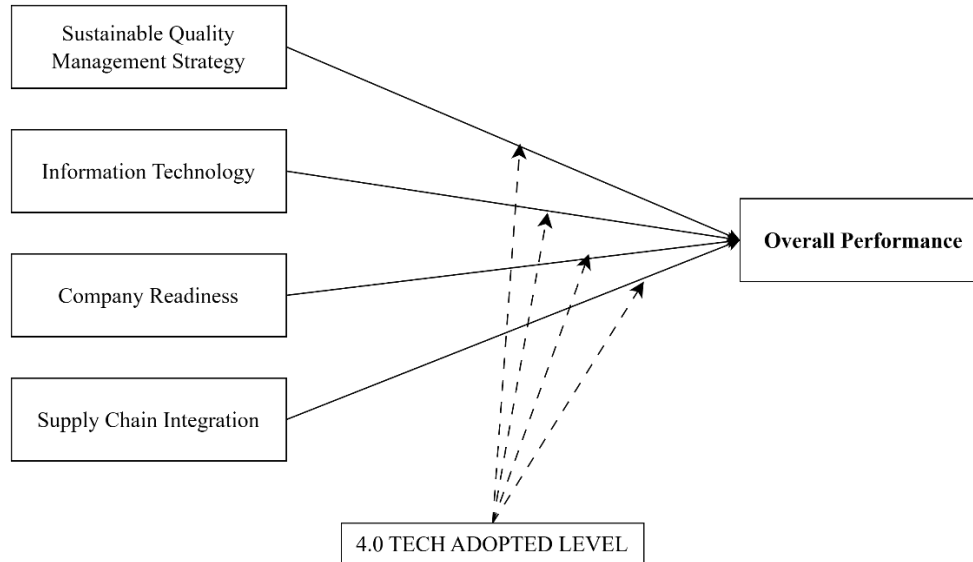
Table 4. 33 1st Model's Bootstrapping Result

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
CP -> SDP	0,229	0,235	0,083	2,756	0,006
CR -> SDP	0,180	0,181	0,088	2,039	0,041
IT -> SDP	0,087	0,081	0,066	1,317	0,188
ITA -> SDP	0,303	0,303	0,050	6,030	0,000
Moderating Effect CP -> SDP	-0,169	-0,163	0,065	2,615	0,009
Moderating Effect CR -> SDP	0,139	0,135	0,073	1,918	0,055
Moderating Effect IT -> SDP	-0,008	-0,012	0,062	0,135	0,892
Moderating Effect SS -> SDP	0,028	0,035	0,056	0,494	0,621
SS -> SDP	0,161	0,165	0,064	2,505	0,012

Source: by Author

Model 2: Assessing the factors SCQM affecting to the OA of a business:

Figure 4. 8 The 2nd Model with Moderator effect of ITA 4.0



Source: by Author

Data analysis on Smart PLS shows the reliability of the model as in Table 4.34. The data shows that the ITA – Industrial 4.0 Technology Adoption factor has stable reliability. However, the study also removed questions about ITA that did not meet the Outer Loading requirements to ensure the AVE index. Specifically, the removed aspects include: ITA2; ITA3; ITA4; ITA6; ITA7; ITA8; and ITA9 (see appendix 8).

Table 4. 34 Construct Reliability and Validity of 2nd Model

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
CP	0,921	0,926	0,938	0,717
CR	0,939	0,940	0,947	0,598
IT	0,841	0,856	0,904	0,758
ITA	0,848	0,850	0,892	0,624
Moderating Effect CP	1,000	1,000	1,000	1,000
Moderating Effect CR	1,000	1,000	1,000	1,000
Moderating Effect IT	1,000	1,000	1,000	1,000
Moderating Effect SS	1,000	1,000	1,000	1,000
OA	0,868	0,869	0,911	0,719
SS	0,924	0,927	0,938	0,653

Source: by Author

The results of the Discriminant Validity analysis also provided data with values consistent with quantitative requirements. The information is presented in Appendix 8. The F-square analysis results in Table 4.35 show no impact other than ITA on OA. Therefore, we will not conduct Bootstrapping evaluation for this model.

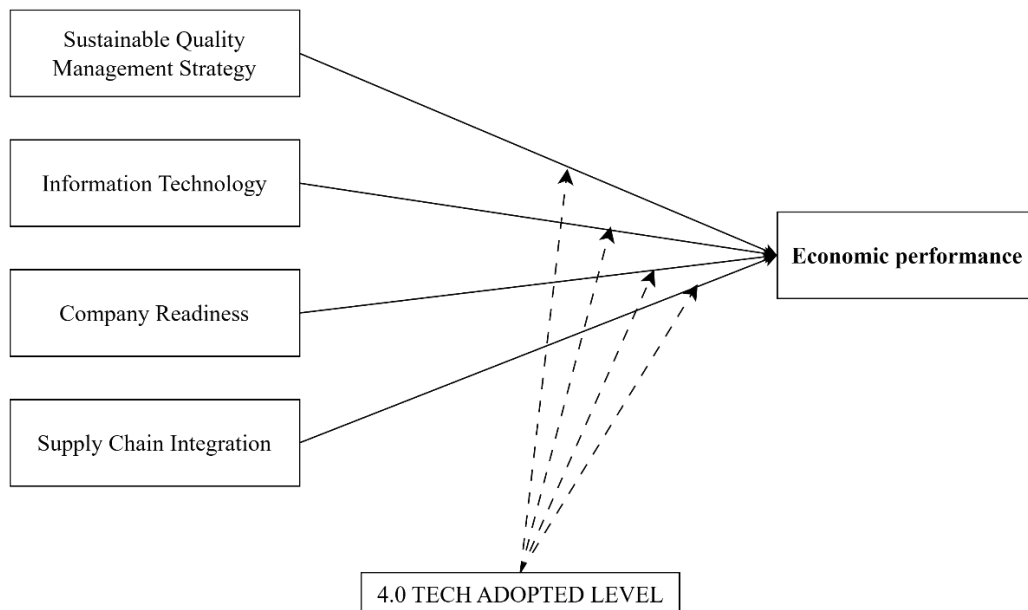
Table 4. 35 2nd Model's F-Square result

	OA
CP	0,006
CR	0,010
IT	0,003
ITA	0,151
Moderating Effect CP	0,019
Moderating Effect CR	0,013
Moderating Effect IT	0,006
Moderating Effect SS	0,001
OA	
SS	0,007

Source: by Author

Model 3 – All Aspects of Economic Performance:

Figure 4. 9 The 3rd Model with Moderator effect of ITA 4.0



Source: by Author

Data analysis on Smart PLS shows the model's reliability level as in Table 4.36. The data indicates that the ITA – Industrial 4.0 Technology Adoption factor has stable reliability. However, the study also removed questions about ITA that did not meet the Outer Loading requirements to ensure the AVE index. Specifically, the removed aspects include: ITA2; ITA3; ITA4; ITA6; ITA7; ITA8; and ITA9 (see appendix 8).

Table 4. 36 Construct Reliability and Validity of 3rd Model

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
CP	0,921	0,922	0,938	0,718
CR	0,939	0,940	0,947	0,598
EP	0,896	0,910	0,916	0,555
IT	0,841	0,845	0,905	0,760
ITA	0,848	0,859	0,892	0,625
Moderating Effect CP	1,000	1,000	1,000	1,000
Moderating Effect CR	1,000	1,000	1,000	1,000
Moderating Effect IT	1,000	1,000	1,000	1,000
Moderating Effect SS	1,000	1,000	1,000	1,000
SS	0,924	0,924	0,938	0,653

Source: by Author

The results of the Discriminant Validity analysis also provided data with values consistent with quantitative requirements. The information is presented in Appendix. The F-square analysis results in Table 4.37 show that it is possible to assess the moderating

effect of ITA on the relationship between CR and CP to SDP. There is no impact of ITA on the SDP of Vietnamese FMCG businesses. In addition, the moderating role of ITA on the relationship between CP (F-square = 0.168) and CR (F-square = 0.023) to Economic Performance is also observed.

Table 4. 37 3rd Model's F-Square result

	EP
CP	0,040
CR	0,002
EP	
ITA	0,002
Moderating Effect CP	0,168
Moderating Effect CR	0,023
Moderating Effect IT	0,014
Moderating Effect SS	0,000
OA	0,000
SS	0,028

Source: by Author

However, Bootstrapping analysis of model 3 in Table 4.38 shows that only the moderating effect of ITA on the relationship between CP and EP is statistically significant. Specifically, the moderating index is inversely related between CP and EP (beta = -0.184; p = 0.033). This result reflects the competition between the technological element of ITA 4.0 and the existing integration of sustainable supply chains in Vietnamese FMCG businesses. This reflects a mindset of replacing technology rather than upgrading existing supply chain integration.

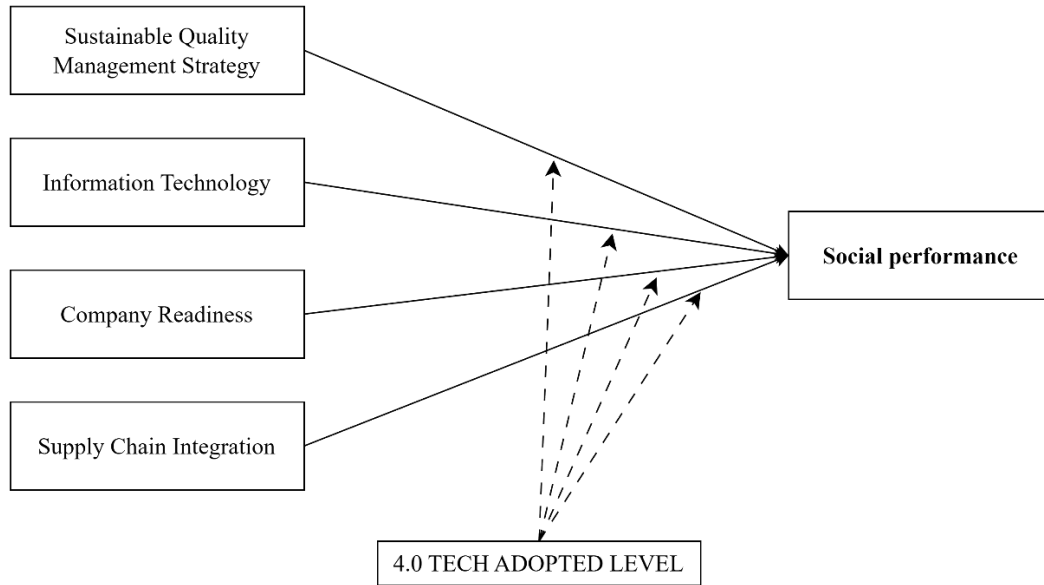
Table 4. 38 3rd Model's Bootstrapping Result

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
CP -> EP	0,266	0,275	0,092	2,880	0,004
CR -> EP	0,057	0,056	0,096	0,588	0,556
IT -> EP	0,048	0,049	0,081	0,596	0,551
ITA -> EP	0,323	0,322	0,056	5,789	0,000
Moderating Effect CP -> EP	-0,184	-0,175	0,087	2,127	0,033
Moderating Effect CR -> EP	0,176	0,182	0,099	1,780	0,075
Moderating Effect IT -> EP	0,010	-0,005	0,092	0,110	0,912
Moderating Effect SS -> EP	-0,001	0,007	0,076	0,012	0,990
SS -> EP	0,193	0,193	0,078	2,466	0,014

Source: by Author

Model 4 – Social Performance Aspect:

Figure 4. 10 The 4th Model with Moderator effect of ITA 4.0



Source: by Author

Data analysis on Smart PLS shows the model's reliability level as in Table 4.39. The data indicates that the ITA – Industrial 4.0 Technology Adoption factor has stable reliability. However, the study also removed questions about ITA that did not meet the Outer Loading requirements to ensure the AVE index. Specifically, the removed aspects include: ITA2; ITA3; ITA4; ITA6; ITA7; ITA8; and ITA9 (see appendix 8).

Table 4. 39 Construct Reliability and Validity of 4th Model

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
CP	0,921	0,923	0,938	0,717
CR	0,939	0,940	0,947	0,598
IT	0,841	0,855	0,904	0,759
ITA	0,841	0,850	0,894	0,680
Moderating Effect CP	1,000	1,000	1,000	1,000
Moderating Effect CR	1,000	1,000	1,000	1,000
Moderating Effect IT	1,000	1,000	1,000	1,000
Moderating Effect SS	1,000	1,000	1,000	1,000
SP	0,916	0,924	0,930	0,570
SS	0,924	0,927	0,937	0,653

Source: by Author

The results of the Discriminant Validity analysis also provided data with values consistent with quantitative requirements. The information is presented in Appendix. The F-square analysis results in Table 4.40 show that ITA 4.0 does not play a moderating role in the relationship between SQCMs and Social Performance in the sustainable development of Vietnamese FMCG businesses.

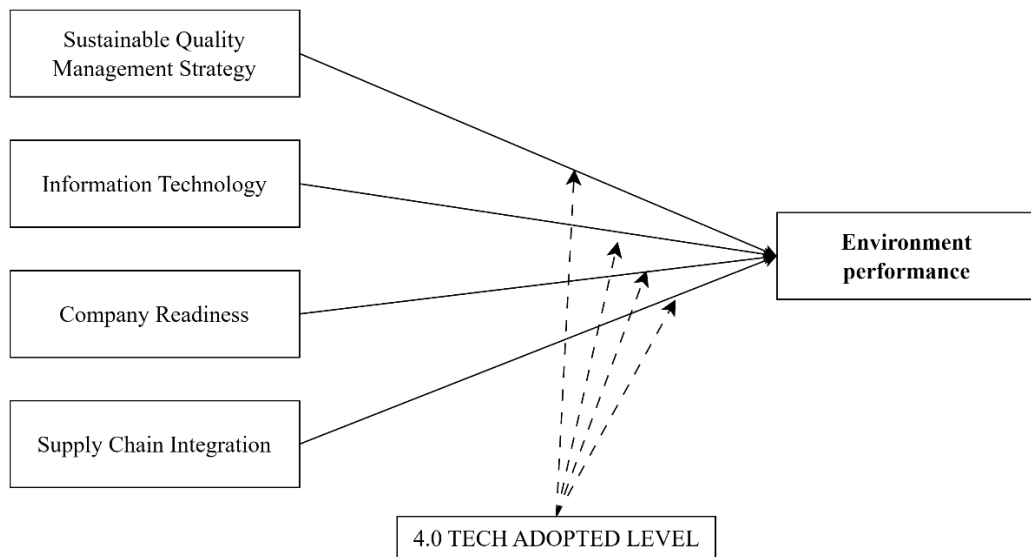
Table 4. 40 4th Model's F-Square result

	SP
CP	0,031
CR	0,022
EP	0,003
ITA	0,099
Moderating Effect CP	0,003
Moderating Effect CR	0,000
Moderating Effect IT	0,002
Moderating Effect SS	0,000
SP	
SS	0,032

Source: by Author

Model 5 – Impact on Environment Efficiency:

Figure 4. 11 The 5th Model with Moderator effect of ITA 4.0



Source: by Author

Data analysis on Smart PLS shows the model's reliability level as in Table 4.41. The data indicates that the ITA – Industrial 4.0 Technology Adoption factor has stable reliability. However, the study also removed questions about ITA that did not meet the Outer Loading requirements to ensure the AVE index. Specifically, the removed aspects include: ITA2; ITA3; ITA4; ITA6; ITA7; ITA8; and ITA9 (see appendix 8).

Table 4. 41 Construct Reliability and Validity of 5th Model

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
CP	0,921	0,926	0,938	0,717
CR	0,939	0,940	0,947	0,598
EVP	0,851	0,866	0,889	0,575
IT	0,841	0,849	0,904	0,759
ITA	0,841	0,852	0,894	0,679
Moderating Effect CP	1,000	1,000	1,000	1,000
Moderating Effect CR	1,000	1,000	1,000	1,000
Moderating Effect IT	1,000	1,000	1,000	1,000
Moderating Effect SS	1,000	1,000	1,000	1,000
SS	0,924	0,924	0,938	0,653

Source: by Author

The results of the Discriminant Validity analysis also provided data with values consistent with quantitative requirements. The information is presented in Appendix 8. The F-square analysis results in Table 4.42 show that although there is some moderation by

ITA, the main influencing factors of CP, CR, SS, and SP are not statistically significant. Therefore, the study did not continue with Bootstrapping evaluation for the fifth model.

Table 4. 42 5th Model's F-Square result

	EVP
CP	0,016
CR	0,020
EVP	
ITA	0,015
Moderating Effect CP	0,105
Moderating Effect CR	0,020
Moderating Effect IT	0,019
Moderating Effect SS	0,022
SP	0,008
SS	0,002

Source: by Author

4.4 Summary of Findings

The research project has completed the process of constructing a measurement scale, collecting data, and evaluating the role of SCQM on SDP and the moderating role of Industrial 4.0 Technology Adoption. Through synthesizing research worldwide, the project has compiled a questionnaire to measure managers' evaluations of SCQM, SDP, and ITA. The project also conducted expert interviews to propose additional aspects not explored in Vietnam by international theories. Specifically, the SCQM groups were separated into six subgroups; the measurement questions were refined to be more relevant and effective. This process has answered the initial research question of the project.

To answer the second research question, the study used SPSS software with Cronbach's Alpha and multiple EFA assessments. A total of five theoretical models were proposed, tested, and evaluated. The aspects of SDP examined included: overall sustainable development effectiveness; general assessment of sustainable development effectiveness; economic effectiveness; social effectiveness; and environmental effectiveness. Specifically, Table 4.43 summarizes the role of each SCQM group in relation to SDP.

Using Smart PLS 3.0 software, this study evaluated the various impacts of Supply Chain Management (SCQM) on Supply Chain Productivity (SDP) in Vietnamese FMCG businesses. Specifically, supply chain integration (CP) had a positive impact on various aspects of SDP. CP had the strongest impact on the economic efficiency of Vietnamese FMCG businesses. Next, the company readiness (CR) factor group played a positive role in the overall efficiency of the supply chain, social efficiency, and environmental efficiency. Regarding Information Technology (IT), the study found a positive role in the overall efficiency of sustainable development in the supply chain, on overall efficiency perception, and on environmental efficiency. Finally, the Sustainable Quality Strategy factor group only impacted the social efficiency of the Vietnamese FMCG supply chain.

Table 4. 43 Impact of each SCQM 4.0 factor group on SDP

	Original Sample (O)	P Values
CP -> SDP	0,399	0,000
CP -> OA	0,331	0,001
CP -> EP	0,442	0,000
CP -> SP	0,316	0,000
CP -> EVP	0,360	0,000
CR -> SDP	0,202	0,009
CR -> OA	0,161	0,072
CR -> EP	0,076	0,435
CR -> SP	0,283	0,002
CR -> EVP	0,188	0,050
IT -> SDP	0,159	0,012
IT -> OA	0,182	0,040
IT -> EP	0,124	0,158
IT -> SP	0,083	0,279
IT -> EVP	0,256	0,003
SS -> SDP	0,107	0,125
SS -> OA	0,031	0,731
SS -> EP	0,148	0,092
SS -> SP	0,159	0,029
SS -> EVP	-0,030	0,765

Source: by Author

For the final research question, the study assessed the moderating role of ITA in the relationship between SCQM factor groups and SDP aspects. Specifically, according to Table 4.44, the study found that in models 1 and 3, ITA plays a moderating role in the

relationship between SCQM and SDP. However, this role is inversely proportional to the original relationship.

Table 4. 44 Bootstrapping and Moderator Effect of ITA to relationship between SCQM and SDP

Model	Relationship	Beta	P Values
1st	CP -> SDP	0,229	0,006
	Moderating Effect CP -> SDP	-0,169	0,009
	ITA -> SDP	0,303	0,000
3rd	CP -> EP	0,266	0,004
	Moderating Effect CP -> EP	-0,184	0,033
	ITA -> EP	0,323	0,000

Source: by Author

Furthermore, within the Industrial 4.0 Technology Adoption group of factors, not all were highly rated by respondents. Specifically, technologies such as 3D printing, cloud computing, blockchain, ERP, RFID, machine communication, and IoT were not accurately assessed or answered by respondents. This resulted in an imbalance in the collected data and a lack of statistical validity.

4.5 Conclusion

Through theoretical research, this study has synthesized a scale to evaluate Supply Chain Management (SCQM), Supply Chain Development Plan (SDP), and Information Technology Assessment (ITA) of FMCG businesses in Vietnam. Regarding SCQM, the study grouped six factors that directly impact SDP. The study identified the main and most comprehensive factor influencing SDP as the supply chain integration aspect. The most

strongly impacted aspect in SDP is the economic aspect, followed by the environment; awareness of sustainable development; and society.

Regarding the moderating role of ITA in the relationship between SCQM and SDP, the study found that its moderating role has an inverse relationship with SCQM and SDP. This demonstrates the alternative role of ITA to existing SCQM measures for FMCG businesses in Vietnam.

CHAPTER V: DISCUSSION

This study is structured into three sequential phases that answer the relevant research questions. Phase 1 involves developing and validating a scale to assess quality management processes in companies; evaluating the effectiveness of sustainable development; and assessing the perceived value of adopting new Industry 4.0 technologies. This scale was then used in interviews with industry experts to adapt it to the Vietnamese fast-moving consumer goods (FMCG) supply chain. Consultants grouped the SCQM factors from five into six, and the aspects of evaluating sustainable development effectiveness were assessed into four dimensions, along with technologies currently prevalent in Vietnam. Phase 2 assesses the impact of SCQM activities on sustainable development effectiveness. Since four different aspects of the sustainable development process of the FMCG supply chain were evaluated, the study published five evaluation models. Specifically, the research topic assesses the strong role of integrated supply chain management in providing solutions for sustainable supply chain quality management in Vietnamese businesses. Phase 3 evaluates the role of the next step in applying new Industry 4.0 technologies to supply chain process management in the operation of SCQM to SDP. The results show that ITA 4.0 has a horizontal regulatory effect on the relationship between relevant aspects, bringing about sustainable development for Vietnamese FMCG companies.

5.1 The first Research Question – Develop research scale

The Vietnamese fast-moving consumer goods (FMCG) industry is considered to have the fastest innovation capacity. With the potential for significant market share growth

from its young population, Vietnamese FMCG products are constantly innovating. Alongside the strong growth of the market, as Vietnam's economy develops and people's incomes increase, customer expectations for FMCG products are also rising. This enables Vietnamese FMCG businesses to adapt and apply technology to enhance competitiveness. In parallel with the global trend towards sustainable development, the Vietnamese market is rapidly beginning to demonstrate high demands for FMCG products regarding brand and product sustainability. According to research by Vuong, under customer pressure, the FMCG industry can generate interest and attention to sustainable development throughout its entire value chain. Technologies are being applied to operational systems and supply chain applications to enhance the effectiveness of sustainable development. creating a just and economically equitable society (Vuong et al., 2024).

Customers, legislatures, and other stakeholders are demanding that organizations achieve higher environmental, social, and financial performance through responsible management of products, processes, and services (Ali et al., 2019) Therefore, sustainable management (SM) is now a strategic parameter for business continuity, to meet current societal needs without compromising the ability to meet future needs. Achieving tripartite (environmental, social, and financial) performance that is, achieving economic profitability while continuously improving environmental and social impact through coordinated policies and strategies is a complex issue for the industry and the sustainability sector (Rajeev et al., 2017).

The integration of three aspects of quality management; sustainability management; and supply chain management helps increase the operational efficiency of businesses. In

theoretical research papers on the topic of SCQM, only about 53% of the papers focus on building theoretical ideas to constitute a theoretical model. Existing research is concentrated mainly in developing countries such as the USA and Europe, with sustainable development effectively encompassing three aspects: environmental, social, and economic.

Although prior studies in Vietnam have examined supply chain quality management, Industry 4.0 adoption, and sustainable performance separately, empirical research integrating these constructs under the SCQM 4.0 framework remains extremely limited. Existing studies mainly focus on single industries such as garment or manufacturing, leaving a significant gap in examining SCQM 4.0 holistically across FMCG and emerging digital supply chain contexts.

In response to this situation, the study synthesized theoretical research and developed a scale to measure the effectiveness of SCQM; sustainable development performance (SDP); and the operation of Industry 4.0 technologies in the Vietnamese FMCG environment.

Research results of the first research question:

Through the process of theoretical synthesis, the study developed a 5-point Likert measurement questionnaire to assess the SCQM processes and the effectiveness of sustainable supply chain development in the Vietnamese FMCG industry. SCQM was evaluated based on two aspects: internal and external resources of the enterprise, with six groups of factors: Top Management Support; Human Resources; Information Technology; Technology Awareness; Information Sharing; and Supply Chain Integration. The study conducted one-on-one interviews with leading experts in the field of sustainable supply

chain management in the FMCG industry in Vietnam. The questionnaire was further refined during interviews with FMCG industry experts to optimize the measurement scale for the study.

The expert interview process also helped to restructure aspects of Sustainability Developed Performance. Specifically, from general measurement questions, the expert group proposed separating the SDP group into four different cognitive aspects: Overall Performance (OA); Economic Performance (EP); Social Performance (SP); and Environmental Performance (EVP). Finally, the expert group also suggested examining the differences between the initial general scale of Sustainability Developed Performance and the suggested subgroups.

5.2 The second Research Question – Assessing the impact of SCQM on SDP:

Based on the data analysis results, the study evaluated five correlation models to assess the impact of each SCQM group on the various aspects of SDP. Each SCQM factor group will have a different impact on the SDP of Vietnamese FMCG enterprises.

Supply Chain Integration Practices to SDP:

In the data analysis, Supply Chain Integration Practices (CP) is the group of SCQM factors that has the most comprehensive impact on the aspects of SDP.

The research results show that supply chain integration has a positive impact on overall sustainable development, which is consistent with previous empirical evidence in Vietnam. According to (L. T. C. Bui et al., 2025), supply chain quality integration allows businesses to synchronize processes, standards, and information among chain members, thereby improving operational efficiency, enhancing transparency, and improving overall

sustainability indicators. When businesses closely coordinate with suppliers and customers, they are able to implement green initiatives, improve social responsibility, and optimize economic efficiency simultaneously. Therefore, supply chain integration is considered a foundational capability that helps businesses balance and enhance all three pillars of sustainable development.

In addition, the research by Cohen indicates that consumer awareness of sustainable supply chains influences a higher willingness to pay for sustainable products (Cohen et al., 2026). This implies that supply chain integration not only brings internal efficiency but also creates external sustainable value through enhanced customer trust and brand image. Therefore, integration throughout the supply chain helps businesses achieve sustainable competitive advantage and promotes overall sustainable development.

Specifically, CP has the strongest impact on the economic sustainability of businesses. In a deeper analysis, Vietnam is an FMCG production market that mainly serves the domestic market, which is an immature market. With such a market nature, Vietnamese FMCG manufacturers always face challenges with factors such as product prices, promotional programs, and especially fluctuations in customers' income. Therefore, FMCG businesses always seek to integrate their supply chains with strategic partners. The aim is to share risks, optimize operational efficiency, enhance quality, and thereby create a sustainable economic development advantage for the business.

Furthermore, supply chain integration enables businesses to respond flexibly to market fluctuations and supply chain disruption risks, which is particularly important in the context of the highly competitive and volatile FMCG market in Vietnam. As a result,

businesses not only improve short-term efficiency but also enhance their ability to maintain sustainable profitability in the long term (Abbey Ngochindo Igwe et al., 2024). This explains your empirical results showing that SCI has the strongest impact on the economic aspect of sustainable development.

From a social development perspective, implementing supply chain integration practices gives FMCG brands a competitive advantage. Specifically, in the era of rapidly developing communication technology, supply chain integration increases the transparency of the supply chain. This creates opportunities to reveal sensitive aspects that society cares about, such as safe working conditions; equality in employment; improving the work environment and efficiency... Therefore, using supply chain integration helps Vietnamese FMCG businesses receive strong social support. Furthermore, close collaboration among partners in the supply chain helps to spread social norms and business ethics, thereby enhancing brand reputation and social acceptance. This explains why, in your research findings, SCI has a positive impact on social sustainability through improved supply chain transparency, working conditions, and corporate social responsibility (Cohen et al., 2026).

The results regarding the positive impact of supply chain integration on the environment are strongly supported by (Kang et al., 2018). This study indicates that green supply chain integration, especially integration with customers and partners, plays a crucial moderating role in implementing effective environmental governance activities. Through sharing environmental information and coordinating green goals, businesses can reduce emissions, optimize resource use, and implement environmentally friendly production processes. Furthermore, (K. Nguyen et al., 2023) also emphasize that supply chain quality

integration helps standardize processes and better control environmentally impactful activities throughout the chain. Therefore, supply chain integration provides a foundation for implementing green supply chain governance and improving sustainable environmental performance.

The results confirm that supply chain integration practices have the most comprehensive positive impact on sustainable development performance in Vietnamese FMCG firms. By aligning processes, standards, and information flows among supply chain partners, integration improves operational efficiency, transparency, and coordinated sustainability initiatives. It has the strongest influence on economic sustainability by enabling risk sharing, cost optimization, and long-term financial resilience. Simultaneously, integration enhances social sustainability through greater transparency and stakeholder trust, and strengthens environmental sustainability by facilitating green collaboration, resource efficiency, and the effective implementation of environmentally friendly practices across the supply chain.

Company readiness practices:

The data evaluation process revealed that both Company readiness practices (CR) and Information sharing practices (IT) have varying degrees of positive impact on the sustainability performance (SDP) assessment aspects of a business.

Specifically, regarding the CR factors, Vietnamese FMCG businesses demonstrate a positive impact on overall sustainable development, social development, and the environment. The most positive impact of CR is on the social development effectiveness of the business (beta = 0.283). Company readiness relates to the level of awareness and

self-preparation of the business in terms of technology, thereby creating an effective sustainable development advantage. The observed aspects include preparation for integrating new technologies; employees' interest in the benefits of new technologies; risk preparation plans and resources for easy technology application... these are aspects of concern to society, customers, and partners.

Company readiness represents a firm's internal capability to implement sustainability-oriented supply chain practices through managerial commitment, technological preparedness, and supportive organizational culture. In emerging economies such as Vietnam, this readiness enables firms to more effectively adopt and operationalize green and socially responsible supply chain initiatives, thereby improving sustainability outcomes across specific dimensions. Prior research shows that organizational preparedness facilitates the implementation of sustainable supply chain practices and enhances environmental and social performance (Zhu et al., 2008). The significant impact on environmental performance arises because prepared firms are better able to implement environmental management systems, green procurement, and resource efficiency practices (Vachon & Klassen, 2006). Moreover, readiness strengthens social sustainability by improving labor practices, supplier compliance, and stakeholder engagement, which are driven by internal capabilities and awareness (Seuring & Müller, 2008b).

Information sharing practices:

Information sharing practices also have a positive impact, but in the aspect of sustainable environmental development. Effective information sharing helps FMCG businesses recognize opportunities and challenges early on, thereby improving operational efficiency and the use of environmental resources.

Information technology enhances supply chain visibility, coordination, and responsiveness, which collectively supports improved overall sustainability outcomes. Through digital transformation, firms can integrate operational, environmental, and governance information, thereby strengthening holistic sustainability performance in Vietnamese supply chains (Ngo et al., 2026). In emerging economies such as Vietnam, IT systems enable real-time monitoring, traceability, and seamless integration of sustainability practices across procurement, production, and distribution processes, reinforcing environmental management and responsible supply chain coordination (M. Akbari et al., 2024). Moreover, digital technologies including IoT, analytics, and integrated information systems directly facilitate waste reduction, emission tracking, and resource optimization. These technology-enabled capabilities explain why IT adoption exerts a particularly strong influence on environmental sustainability performance while simultaneously contributing to broader multidimensional sustainability improvements in Vietnamese supply chains (Ngo et al., 2026).

Sustainable Quality Management Strategy Practices:

Finally, there is the Sustainable Quality Management Strategy (SQMS) group of factors. The finding that SQMS affects social sustainability but not economic, environmental, or overall sustainability performance can be explained by the specific context of the FMCG supply chain in Vietnam. Vietnamese FMCG businesses are still considering strategies and plans to support sustainable quality development at a reactive and ineffective level.

Prior studies indicate that sustainable supply chain practices in Vietnam are often implemented to enhance corporate social responsibility, stakeholder trust, and customer satisfaction rather than to achieve immediate financial or environmental gains (Le et al., 2024). This reflects the characteristics of an emerging market, where firms initially focus on ethical sourcing, employee welfare, and community engagement, leading to stronger impact on the social dimension. Moreover, research on green supply chain management in Vietnam shows that improvements in firm performance and comprehensive sustainability outcomes typically occur through mediating mechanisms such as competitive advantage and supply chain integration rather than through strategic orientation alone (L. T. C. Bui et al., 2025). Therefore, while SQMS strengthens social sustainability, it may not directly translate into economic, environmental, or overall sustainability performance within the Vietnamese FMCG sector.

5.3 The third Research Question – Assessing the moderating role of Industrial 4.0

Technology Adoption on the impact between SCQM and SDP:

In the third part of the research, the author assesses the moderating role of new Industry 4.0 technologies in the relationship between SCQM and SDP in Vietnamese FMCG businesses. Data analysis reveals that Vietnamese FMCG businesses do not yet fully understand the role of several new technologies such as 3D printing; cloud technology; blockchain technology; ERP technology; RFID technology; machine communication technology; and the Internet of Things. Although these technologies have spread rapidly in Vietnam in recent years, they may not be effectively applied in the field of supply chain quality management within Vietnamese FMCG companies.

Other technologies such as AI, robotics, CPS, and big data received positive responses from respondents. Specifically, these technologies have a positive impact on the business's SDP. Data analysis indicators from SmartPLS clearly and strongly demonstrate this role. In some aspects of SDP assessment, such as social development effectiveness, environmental impact, and overall performance, these technology groups have a more prominent impact than SCQM.

Considering the regulatory role of ITA in the overall SDP effectiveness assessment model and the economic sustainability (EP) aspect, the regulatory role of ITA is demonstrated inversely to the relationship between SCQM and SDP. Specifically, the supply chain integration aspect of SCQM has a reduced positive impact on SDP and EP when ITA is present.

Prior studies suggest that the adoption of Industry 4.0 technologies significantly moderates the relationship between supply chain integration and sustainable development performance. Digital technologies such as AI, big data analytics, and blockchain tend to replace or enhance traditional integration mechanisms by enabling real-time coordination, data-driven decision-making, and automated process control (Bag et al., 2021; Dubey et al., 2019). As firms increasingly rely on these advanced technologies, the direct contribution of conventional supply chain integration practices to sustainability outcomes, particularly economic and overall performance, may diminish. Similarly, blockchain and IoT-based coordination can substitute for traditional integration structures, thereby shifting the performance driver from managerial integration to technological capability (Queiroz & Fosso Wamba, 2019). Empirical evidence also indicates that Industry 4.0 adoption becomes a dominant predictor of sustainable performance, reducing the relative effect of integration-based quality management practices (Kamble et al., 2020). This explains why, in Vietnamese FMCG firms, ITA negatively moderates the SCQM and SDP relationship, as advanced technologies increasingly replace traditional quality integration mechanisms in driving economic and overall sustainability performance.

5.4 Conclusion

The research topic, conducted in three phases, involved synthesis and research to uncover new aspects in assessing the level of SCQM, the effectiveness of SDP and the regulatory role of ITA in this relationship. The tools used in this study included: theoretical synthesis; development of a research scale; qualitative research through in-depth expert interviews; and quantitative research to identify the findings.

Specifically, the study successfully developed a scale to assess the SCQM of Vietnamese FMCG businesses. This scale was refined for effectiveness and reliability to serve future research. Simultaneously, the study proposed five assessment models to aid in researching the sustainable development of Vietnamese FMCG businesses. The study shows that managers can use a comprehensive scale encompassing multiple aspects of the SDP or use detailed assessments of specific aspects (economic; social; environmental; and overall assessment of development).

Furthermore, the study also highly values the role of supply chain integration practices in the overall sustainable development of Vietnam's FMCG industry. Given the industry's characteristics of being sensitive, fast-paced, and full of opportunities, FMCG companies clearly demonstrate their understanding of supply chain integration to create a multi-dimensional, sustainable development advantage.

Finally, the study also assessed the moderating role of Industrial 4.0 Technology Adoption in the relationship between SCQM and SDP. In this assessment, ITA (Industrial 4.0 Adoption) played a moderating role, replacing the existing relationship between SCQM and SDP.

CHAPTER VI: SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

6.1 Summary

The study was conducted in three phases to develop a scale and evaluate the relationship between Supply Chain Quality Management (SCQM), Sustainable Development Performance (SDP), and the adoption of Industry 4.0 (ITA) in the fast-moving consumer goods (FMCG) industry in Vietnam. The results show that integrated supply chain activities have the most comprehensive and powerful impact on both economic and social sustainability, helping businesses optimize efficiency and increase transparency. While factors such as company readiness and information sharing contribute positively to environmental and social aspects, the study also indicates that the adoption of new technologies such as AI and Big Data is gradually playing a regulatory role, even tending to replace traditional management tools to promote sustainable development in a rapidly changing market.

6.2 Implications

The study combined measurement scales to assess the level of application in supply chain management efficiency (SCQM), the level of sustainable development of enterprises, and selected new technologies in the Industry 4.0 revolution.

First, through the research process, the study assessed the stability of the SCQM and SDP scales, thereby forming a tool to help FMCG businesses self-assess their level of sustainable development and supply chain quality management.

Next, the study also investigated the role of SCQM factors in influencing the SDP of FMCG businesses. As predicted, the results highlighted the role of supply chain integration with stakeholders in creating strong sustainable development. Simultaneously, information sharing measures and company readiness also had a positive impact on many aspects of SDP development.

Finally, the study assessed the extent to which ITA controls the relationship between SCQM and SDP. Specifically, some aspects of ITA have a positive impact on SDP. At the same time, these technologies also serve as alternatives to existing SCQMs.

6.3 Recommendations for Future Research

This research proposes further investigation and development of a measurement scale for the Sustainability Quality Management Strategy (SS) aspect. Global studies consider this aspect a crucial part of ensuring business sustainability. However, research conducted within the Vietnamese FMCG sector has shown that this aspect has been inadequately studied and has had little impact on the SDP (Sustainability Development Performance).

Furthermore, this study proposes further research into the group of Industry 4.0 technologies that were rejected in this study. Technologies such as RFID, blockchain, and IoT are widely applied in the operations of modern businesses. They have been extensively evaluated and tested in the operational and production sectors. However, in the research conducted within the FMCG sector, the results obtained lacked statistical data.

Lastly, researcher should be consider to convert the moderating role of ITA as the main factor to evaluate the impact to SDP.

6.4 Limitation of the study

With limited resources, the topic can only synthesize primary studies from the period 2022 and earlier. The proposed risk aspects to be studied are therefore not updated. Data collected from the implementation topic only focuses on enterprises at a systematic scale. Meanwhile, the Vietnamese FMCG industry focuses more than 90-95% on small and medium enterprises - SMEs. This makes the assessment data somewhat focused on large-scale enterprises and does not cover the entire industry.

The research topic has only explored aspects of sustainable development that are currently receiving attention. Many other aspects of sustainable effectiveness have not been adequately considered or investigated.

6.5 Conclusion

This research has successfully fulfilled its primary objective of exploring the intersection of Supply Chain Quality Management (SCQM) 4.0, Industry 4.0 technology adoption, and Sustainable Development Performance (SDP) within the context of the Fast-Moving Consumer Goods (FMCG) sector in Vietnam. By synthesizing theoretical frameworks and conducting empirical analysis from 250 enterprises, several key conclusions have been drawn:

First, the study has established and validated a comprehensive measurement scale for SCQM 4.0 and SDP. The adaptation of these scales through expert interviews ensured that the academic constructs were not only robust but also practically relevant to the specific dynamics of the Vietnamese FMCG market.

Second, the findings provide strong evidence that SCQM 4.0 practices have a direct and positive impact on sustainable performance. Notably, Supply Chain Integration emerged as the most critical factor driving sustainability. This underscores that quality management is no longer just about operational efficiency; it is a strategic tool for enhancing environmental responsibility and social equity.

Third, a significant contribution of this study is the identification of the moderating role of Industry 4.0 Technology Adoption (ITA). The results indicate a negative moderating effect, suggesting that in the current Vietnamese context, advanced technologies may act as a powerful substitute or a leapfrogging mechanism for traditional management practices to achieve sustainability goals. However, the study also highlights a gap in the adoption of cutting-edge technologies like Blockchain and IoT, which remain underutilized due to resource constraints and a focus on large-scale systematic enterprises. In conclusion, to remain competitive and resilient in the post-pandemic era, Vietnamese FMCG companies must transition from traditional supply chain models to SCQM 4.0. Investing in digital transformation, coupled with a holistic quality strategy across the entire supply chain, is the "key" to achieving both operational excellence and long-term sustainable growth.

REFERENCE

- Abbate, T., Vecco, M., Vermiglio, C., Zarone, V., & Perano, M. (2022). Blockchain and art market: resistance or adoption? *Consumption Markets & Culture*, 25(2), 105–123. <https://doi.org/10.1080/10253866.2021.2019026>
- Abbey Ngochindo Igwe, Nsiong Louis Eyo-Udo, Adekunle Stephen Toromade, & Titilope Tosin Adewale. (2024). Policy implications and economic incentives for sustainable supply chain practices in the food and FMCG Sectors. *Comprehensive Research and Reviews Journal*, 2(1), 023–036. <https://doi.org/10.57219/crrj.2024.2.1.0027>
- Accorsi, R., Bortolini, M., Baruffaldi, G., Pilati, F., & Ferrari, E. (2017). Internet-of-things Paradigm in Food Supply Chains Control and Management. *Procedia Manufacturing*, 11, 889–895. <https://doi.org/10.1016/j.promfg.2017.07.192>
- Accorsi, R., Cholette, S., Manzini, R., & Tufano, A. (2018). A hierarchical data architecture for sustainable food supply chain management and planning. *Journal of Cleaner Production*, 203, 1039–1054. <https://doi.org/10.1016/j.jclepro.2018.08.275>
- Acioli, C., Scavarda, A., & Reis, A. (2021). Applying Industry 4.0 technologies in the COVID–19 sustainable chains. *International Journal of Productivity and Performance Management*, 70(5), 988–1016. <https://doi.org/10.1108/IJPPM-03-2020-0137>

- Aguinis, H., & Glavas, A. (2012). What We Know and Don't Know About Corporate Social Responsibility. *Journal of Management*, 38(4), 932–968. <https://doi.org/10.1177/0149206311436079>
- Ahmed, S., Taqi, H. Md. M., Farabi, Y. I., Sarker, M., Ali, S. M., & Sankaranarayanan, B. (2021). Evaluation of Flexible Strategies to Manage the COVID-19 Pandemic in the Education Sector. *Global Journal of Flexible Systems Management*, 22(S2), 81–105. <https://doi.org/10.1007/s40171-021-00267-9>
- Ahmed, W., Najmi, A., & Ikram, M. (2020). Steering firm performance through innovative capabilities: A contingency approach to innovation management. *Technology in Society*, 63, 101385. <https://doi.org/10.1016/j.techsoc.2020.101385>
- Akbar, U., Kumar, A., Khan, H., Khan, M. A., Parvaiz, K., & Oláh, J. (2020). Trade-Offs in Competitive Transport Operations. *Economies*, 8(3), 56. <https://doi.org/10.3390/economies8030056>
- Akbari, A., & Rahimi, M. (2025). Estimation of water saturation in an oil reservoir using nine different machine learning techniques: a case study. *Geosystem Engineering*, 1–27. <https://doi.org/10.1080/12269328.2025.2566843>
- Akbari, M., Kok, S. K., Hopkins, J., Frederico, G. F., Nguyen, H., & Alonso, A. D. (2024). The changing landscape of digital transformation in supply chains: impacts of industry 4.0 in Vietnam. *The International Journal of Logistics Management*, 35(4), 1040–1072. <https://doi.org/10.1108/IJLM-11-2022-0442>

- Ali, M. H., Zailani, S., Iranmanesh, M., & Foroughi, B. (2019). Impacts of Environmental Factors on Waste, Energy, and Resource Management and Sustainable Performance. *Sustainability*, 11(8), 2443. <https://doi.org/10.3390/su11082443>
- Alter, S. (2008). Service system fundamentals: Work system, value chain, and life cycle. *IBM Systems Journal*, 47(1), 71–85. <https://doi.org/10.1147/sj.471.0071>
- Amorim, P., Curcio, E., Almada-Lobo, B., Barbosa-Póvoa, A. P. F. D., & Grossmann, I. E. (2016). Supplier selection in the processed food industry under uncertainty. *European Journal of Operational Research*, 252(3), 801–814. <https://doi.org/10.1016/j.ejor.2016.02.005>
- Antony, J., Sony, M., Furterer, S., McDermott, O., & Pepper, M. (2022). Quality 4.0 and its impact on organizational performance: an integrative viewpoint. *The TQM Journal*, 34(6), 2069–2084. <https://doi.org/10.1108/TQM-08-2021-0242>
- Badia-Melis, R., Mc Carthy, U., Ruiz-Garcia, L., Garcia-Hierro, J., & Robla Villalba, J. I. (2018). New trends in cold chain monitoring applications - A review. *Food Control*, 86, 170–182. <https://doi.org/10.1016/j.foodcont.2017.11.022>
- Badia-Melis, R., Mishra, P., & Ruiz-García, L. (2015). Food traceability: New trends and recent advances. A review. *Food Control*, 57, 393–401. <https://doi.org/10.1016/j.foodcont.2015.05.005>
- Bag, S., Pretorius, J. H. C., Gupta, S., & Dwivedi, Y. K. (2021). Role of institutional pressures and resources in the adoption of big data analytics powered artificial intelligence, sustainable manufacturing practices and circular economy

- capabilities. *Technological Forecasting and Social Change*, 163, 120420.
<https://doi.org/10.1016/j.techfore.2020.120420>
- Bag, S., Routray, S., & Aytac, B. (2025). Linking digital transformation to ESG outcomes: A mixed-methods study on SRM capability and coopetition in supply networks. *Journal of Environmental Management*, 392, 126801.
<https://doi.org/10.1016/j.jenvman.2025.126801>
- Bai, C., Sarkis, J., & Dou, Y. (2015). Corporate sustainability development in China: review and analysis. *Industrial Management & Data Systems*, 115(1), 5–40.
<https://doi.org/10.1108/IMDS-09-2014-0258>
- Ballou, R. H. (2007). The evolution and future of logistics and supply chain management. *European Business Review*, 19(4), 332–348.
<https://doi.org/10.1108/09555340710760152>
- Barata, J., Rupino Da Cunha, P., & Stal, J. (2018). Mobile supply chain management in the Industry 4.0 era. *Journal of Enterprise Information Management*, 31(1), 173–192. <https://doi.org/10.1108/JEIM-09-2016-0156>
- Barney, J. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management*, 17(1), 99–120. <https://doi.org/10.1177/014920639101700108>
- Barney, J. B. (2001). Resource-based theories of competitive advantage: A ten-year retrospective on the resource-based view. *Journal of Management*, 27(6), 643–650. <https://doi.org/10.1177/014920630102700602>
- Barney, J. B., & Arikan, A. M. (2006). *The Resource-based View: Origins and Implications THE THEORETICAL HISTORY OF THE RBV.*

- Barreto, L., Amaral, A., & Pereira, T. (2017). Industry 4.0 implications in logistics: an overview. *Procedia Manufacturing*, 13, 1245–1252.
<https://doi.org/10.1016/j.promfg.2017.09.045>
- Bastas, A., & Liyanage, K. (2018a). Sustainable supply chain quality management: A systematic review. *Journal of Cleaner Production*, 181, 726–744.
<https://doi.org/10.1016/j.jclepro.2018.01.110>
- Bastas, A., & Liyanage, K. (2018b). Sustainable supply chain quality management: A systematic review. *Journal of Cleaner Production*, 181, 726–744.
<https://doi.org/10.1016/j.jclepro.2018.01.110>
- Bayo-Moriones, A., Bello-Pintado, A., & Merino-Díaz-de-Cerio, J. (2011). Quality assurance practices in the global supply chain: the effect of supplier localisation. *International Journal of Production Research*, 49(1), 255–268.
<https://doi.org/10.1080/00207543.2010.508953>
- Ben-Daya, M., Hassini, E., & Bahroun, Z. (2019). Internet of things and supply chain management: a literature review. *International Journal of Production Research*, 57(15–16), 4719–4742. <https://doi.org/10.1080/00207543.2017.1402140>
- Bennett, M., James, P., & Leon Klinkers, with. (2000). Sustainable Measures - Evaluation and Reporting of Environmental and Social Performance. *International Journal of Sustainability in Higher Education*, 1(1), ijshe.2000.24901aae.004. <https://doi.org/10.1108/ijshe.2000.24901aae.004>
- Beske, P., Land, A., & Seuring, S. (2014). Sustainable supply chain management practices and dynamic capabilities in the food industry: A critical analysis of the

- literature. *International Journal of Production Economics*, 152, 131–143.
<https://doi.org/10.1016/j.ijpe.2013.12.026>
- Binh, A. D. T., Majo, A. M., Nguyen, K., Nguyen, S., Phraknoi, N., Haq, I. U., Chu, T., & Quang, H. T. (2025). Towards Sustainable Development: Unveiling the Synergies of Industry 4.0, Quality Management, and Supply Chain Management Through SCQM 4.0. In *The Synergistic Effect of Sustainable Business Practices on Corporate Performance* (pp. 1–24). Springer Nature Singapore.
https://doi.org/10.1007/978-981-96-3375-3_1
- Birkel, H. S., Veile, J. W., Müller, J. M., Hartmann, E., & Voigt, K.-I. (2019). Development of a Risk Framework for Industry 4.0 in the Context of Sustainability for Established Manufacturers. *Sustainability*, 11(2), 384.
<https://doi.org/10.3390/su11020384>
- Boateng-Okrah, E., & Appiah Fening, F. (2012). TQM implementation: a case of a mining company in Ghana. *Benchmarking: An International Journal*, 19(6), 743–759. <https://doi.org/10.1108/14635771211284305>
- Bouranta, N., Psomas, E. L., & Pantouvakis, A. (2017). Identifying the critical determinants of TQM and their impact on company performance. *The TQM Journal*, 29(1), 147–166. <https://doi.org/10.1108/TQM-11-2015-0142>
- Brizio, A. P. D. R., & Prentice, C. (2014). Use of smart photochromic indicator for dynamic monitoring of the shelf life of chilled chicken based products. *Meat Science*, 96(3), 1219–1226. <https://doi.org/10.1016/j.meatsci.2013.11.006>

- Bui, L. T. C., Carvalho, M., Pham, H. T., Nguyen, T. T. B., Duong, A. T. B., & Truong Quang, H. (2025). Supply chain quality management 4.0: conceptual and maturity frameworks. *International Journal of Quality & Reliability Management*, 42(3), 785–808. <https://doi.org/10.1108/IJQRM-07-2021-0251>
- Bui, T., Tseng, J., Tran, T. P. T., Ha, H. M., Lim, M. K., & Tseng, M. (2023a). Circular supply chain strategy in Industry 4.0: The canned food industry in Vietnam. *Business Strategy and the Environment*, 32(8), 6047–6073. <https://doi.org/10.1002/bse.3472>
- Bui, T., Tseng, J., Tran, T. P. T., Ha, H. M., Lim, M. K., & Tseng, M. (2023b). Circular supply chain strategy in Industry 4.0: The canned food industry in Vietnam. *Business Strategy and the Environment*, 32(8), 6047–6073. <https://doi.org/10.1002/bse.3472>
- Cao, M., & Zhang, Q. (2011). Supply chain collaboration: Impact on collaborative advantage and firm performance. *Journal of Operations Management*, 29(3), 163–180. <https://doi.org/10.1016/j.jom.2010.12.008>
- Caro, M. P., Ali, M. S., Vecchio, M., & Giaffreda, R. (2018). Blockchain-based traceability in Agri-Food supply chain management: A practical implementation. *2018 IoT Vertical and Topical Summit on Agriculture - Tuscany (IOT Tuscany)*, 1–4. <https://doi.org/10.1109/IOT-TUSCANY.2018.8373021>
- Carter, C. R., Hatton, M. R., Wu, C., & Chen, X. (2019). Sustainable supply chain management: continuing evolution and future directions. *International Journal*

- of *Physical Distribution & Logistics Management*, 50(1), 122–146.
<https://doi.org/10.1108/IJPDLM-02-2019-0056>
- Carter, C. R., & Rogers, D. S. (2008). A framework of sustainable supply chain management: moving toward new theory. *International Journal of Physical Distribution & Logistics Management*, 38(5), 360–387.
<https://doi.org/10.1108/09600030810882816>
- Celma, D., Martinez-Garcia, E., & Raya, J. M. (2018). Socially responsible HR practices and their effects on employees' wellbeing: Empirical evidence from Catalonia, Spain. *European Research on Management and Business Economics*, 24(2), 82–89. <https://doi.org/10.1016/j.iedeen.2017.12.001>
- Chaghooshi, A. J., Soltani-Neshan, M., & Moradi-Moghadam, M. (2015). Canonical Correlation Analysis Between Supply Chain Quality Management And Competitive Advantages. *Foundations of Management*, 7(1), 83–92.
<https://doi.org/10.1515/fman-2015-0027>
- Chakraborty, D., & Dey, O. (2024). Trade, Environment and Climate Change. In *Influence of WTO and Global Dynamics on Trade Flows* (pp. 289–347). Springer Nature Singapore. https://doi.org/10.1007/978-981-99-7375-0_4
- Chardine-Baumann, E., & Botta-Genoulaz, V. (2014). A framework for sustainable performance assessment of supply chain management practices. *Computers & Industrial Engineering*, 76, 138–147. <https://doi.org/10.1016/j.cie.2014.07.029>
- Chari, A., Niedenzu, D., Despeisse, M., Machado, C. G., Azevedo, J. D., Boavida-Dias, R., & Johansson, B. (2022). Dynamic capabilities for circular

- manufacturing supply chains—Exploring the role of Industry 4.0 and resilience. *Business Strategy and the Environment*, 31(5), 2500–2517. <https://doi.org/10.1002/bse.3040>
- Chen, G., Xu, B., Lu, M., & Chen, N.-S. (2018). Exploring blockchain technology and its potential applications for education. *Smart Learning Environments*, 5(1), 1. <https://doi.org/10.1186/s40561-017-0050-x>
- Cheung, K. L., & Leung, K. F. (2000). Coordinating replenishments in a supply chain with quality control considerations. *Production Planning & Control*, 11(7), 697–705. <https://doi.org/10.1080/095372800432160>
- Cogollo-Flórez, J. M., & Correa-Espinal, A. A. (2019). Analytical modeling of supply chain quality management coordination and integration: A literature review. *Quality Management Journal*, 26(2), 72–83. <https://doi.org/10.1080/10686967.2019.1580553>
- Cohen, L. H., Gurun, U. G., & Nguyen, Q. H. (2026). The ESG-Innovation Disconnect: Evidence from Green Patenting. *Management Science*. <https://doi.org/10.1287/mnsc.2024.09124>
- Cooper, M. C., Lambert, D. M., & Pagh, J. D. (1997). Supply Chain Management: More Than a New Name for Logistics. *The International Journal of Logistics Management*, 8(1), 1–14. <https://doi.org/10.1108/09574099710805556>
- Coroama, V. C., Hilty, L. M., & Birtel, M. (2012). Effects of Internet-based multiple-site conferences on greenhouse gas emissions. *Telematics and Informatics*, 29(4), 362–374. <https://doi.org/10.1016/j.tele.2011.11.006>

- Coyne, I. T. (1997). Sampling in qualitative research. Purposeful and theoretical sampling; merging or clear boundaries? *Journal of Advanced Nursing*, 26(3), 623–630. <https://doi.org/10.1046/j.1365-2648.1997.t01-25-00999.x>
- Cui, R., & Wang, J. (2022). Shaping sustainable development: External environmental pressure, exploratory green learning, and radical green innovation. *Corporate Social Responsibility and Environmental Management*, 29(3), 481–495. <https://doi.org/10.1002/csr.2213>
- Da Silva, V. L., Kovalski, J. L., Pagani, R. N., Silva, J. D. M., & Corsi, A. (2020). Implementation of Industry 4.0 concept in companies: empirical evidences. *International Journal of Computer Integrated Manufacturing*, 33(4), 325–342. <https://doi.org/10.1080/0951192X.2019.1699258>
- Dabbene, F., Gay, P., & Tortia, C. (2014). Traceability issues in food supply chain management: A review. *Biosystems Engineering*, 120, 65–80. <https://doi.org/10.1016/j.biosystemseng.2013.09.006>
- Danish, Baloch, M. A., Mahmood, N., & Zhang, J. W. (2019). Effect of natural resources, renewable energy and economic development on CO2 emissions in BRICS countries. *Science of The Total Environment*, 678, 632–638. <https://doi.org/10.1016/j.scitotenv.2019.05.028>
- Dantas, T. E. T., de-Souza, E. D., Destro, I. R., Hammes, G., Rodriguez, C. M. T., & Soares, S. R. (2021). How the combination of Circular Economy and Industry 4.0 can contribute towards achieving the Sustainable Development Goals.

- Sustainable Production and Consumption*, 26, 213–227.
<https://doi.org/10.1016/j.spc.2020.10.005>
- Dao, V., Langella, I., & Carbo, J. (2011). From green to sustainability: Information Technology and an integrated sustainability framework. *The Journal of Strategic Information Systems*, 20(1), 63–79.
<https://doi.org/10.1016/j.jsis.2011.01.002>
- Das, K., & Sengupta, S. (2010). Modelling supply chain network: a quality-oriented approach. *International Journal of Quality & Reliability Management*, 27(5), 506–526. <https://doi.org/10.1108/02656711011043508>
- Dedrick, J. (2010). Green IS: Concepts and Issues for Information Systems Research. *Communications of the Association for Information Systems*, 27.
<https://doi.org/10.17705/1CAIS.02711>
- Dev, N. K., Shankar, R., & Qaiser, F. H. (2020). Industry 4.0 and circular economy: Operational excellence for sustainable reverse supply chain performance. *Resources, Conservation and Recycling*, 153, 104583.
<https://doi.org/10.1016/j.resconrec.2019.104583>
- Ding, W., Levine, R., Lin, C., & Xie, W. (2021). Corporate immunity to the COVID-19 pandemic. *Journal of Financial Economics*, 141(2), 802–830.
<https://doi.org/10.1016/j.jfineco.2021.03.005>
- Dubey, R., Gunasekaran, A., Childe, S. J., Blome, C., & Papadopoulos, T. (2019). Big Data and Predictive Analytics and Manufacturing Performance: Integrating Institutional Theory, Resource-Based View and Big Data Culture. *British*

Journal of Management, 30(2), 341–361. <https://doi.org/10.1111/1467-8551.12355>

Dumont, J., Shen, J., & Deng, X. (2017). Effects of Green HRM Practices on Employee Workplace Green Behavior: The Role of Psychological Green Climate and Employee Green Values. *Human Resource Management*, 56(4), 613–627. <https://doi.org/10.1002/hrm.21792>

Elkington, J. (2006). Governance for Sustainability*. *Corporate Governance: An International Review*, 14(6), 522–529. <https://doi.org/10.1111/j.1467-8683.2006.00527.x>

Enz, M. G., & Lambert, D. M. (2015). Measuring the Financial Benefits of Cross-Functional Integration Influences Management's Behavior. *Journal of Business Logistics*, 36(1), 25–48. <https://doi.org/10.1111/jbl.12068>

Esmailian, B., Sarkis, J., Lewis, K., & Behdad, S. (2020). Blockchain for the future of sustainable supply chain management in Industry 4.0. *Resources, Conservation and Recycling*, 163, 105064. <https://doi.org/10.1016/j.resconrec.2020.105064>

Fareed, M. Z., & Su, Q. (2022). Project Governance and Project Performance: The Moderating Role of Top Management Support. *Sustainability*, 14(5), 2516. <https://doi.org/10.3390/su14052516>

Farias, L. M. S., Santos, L. C., Gohr, C. F., Oliveira, L. C. de, & Amorim, M. H. da S. (2019). Criteria and practices for lean and green performance assessment:

- Systematic review and conceptual framework. *Journal of Cleaner Production*, 218, 746–762. <https://doi.org/10.1016/j.jclepro.2019.02.042>
- Fatorachian, H., & Kazemi, H. (2021). Impact of Industry 4.0 on supply chain performance. *Production Planning & Control*, 32(1), 63–81. <https://doi.org/10.1080/09537287.2020.1712487>
- FAWCETT, S. E., WALLIN, C., ALLRED, C., FAWCETT, A. M., & MAGNAN, G. M. (2011). INFORMATION TECHNOLOGY AS AN ENABLER OF SUPPLY CHAIN COLLABORATION: A DYNAMIC-CAPABILITIES PERSPECTIVE. *Journal of Supply Chain Management*, 47(1), 38–59. <https://doi.org/10.1111/j.1745-493X.2010.03213.x>
- Feng Tian. (2016). An agri-food supply chain traceability system for China based on RFID & blockchain technology. *2016 13th International Conference on Service Systems and Service Management (ICSSSM)*, 1–6. <https://doi.org/10.1109/ICSSSM.2016.7538424>
- Fernandes, A. C., Vilhena, E., Oliveira, R., Sampaio, P., & Carvalho, M. S. (2022). Supply chain quality management impact on organization performance: results from an international survey. *International Journal of Quality & Reliability Management*, 39(2), 630–646. <https://doi.org/10.1108/IJQRM-05-2020-0159>
- Fernando, Y., Halili, M., Tseng, M.-L., Tseng, J. W., & Lim, M. K. (2022). Sustainable social supply chain practices and firm social performance: Framework and empirical evidence. *Sustainable Production and Consumption*, 32, 160–172. <https://doi.org/10.1016/j.spc.2022.04.020>

- Flynn, B. B., Huo, B., & Zhao, X. (2010). The impact of supply chain integration on performance: A contingency and configuration approach. *Journal of Operations Management*, 28(1), 58–71. <https://doi.org/10.1016/j.jom.2009.06.001>
- Flynn, B. B., Schroeder, R. G., & Sakakibara, S. (1994). A framework for quality management research and an associated measurement instrument. *Journal of Operations Management*, 11(4), 339–366. [https://doi.org/10.1016/S0272-6963\(97\)90004-8](https://doi.org/10.1016/S0272-6963(97)90004-8)
- Ford, M. W. (2015). Supply Chain Quality Management and Environmental Uncertainty: A Contingency Perspective. *Quality Management Journal*, 22(4), 54–65. <https://doi.org/10.1080/10686967.2015.11918450>
- Foster, S. T., & Ogden, J. (2008). On differences in how operations and supply chain managers approach quality management. *International Journal of Production Research*, 46(24), 6945–6961. <https://doi.org/10.1080/00207540802010815>
- Frank, A. G., Dalenogare, L. S., & Ayala, N. F. (2019). Industry 4.0 technologies: Implementation patterns in manufacturing companies. *International Journal of Production Economics*, 210, 15–26. <https://doi.org/10.1016/j.ijpe.2019.01.004>
- Frederico, G. F., Garza-Reyes, J. A., Anosike, A., & Kumar, V. (2019). Supply Chain 4.0: concepts, maturity and research agenda. *Supply Chain Management: An International Journal*, 25(2), 262–282. <https://doi.org/10.1108/SCM-09-2018-0339>
- Frederico, G. F., Garza-Reyes, J. A., Kumar, A., & Kumar, V. (2020). Performance measurement for supply chains in the Industry 4.0 era: a balanced scorecard

- approach. *International Journal of Productivity and Performance Management*, 70(4), 789–807. <https://doi.org/10.1108/IJPPM-08-2019-0400>
- Fritz, M. M. C. (2022). A supply chain view of sustainability management. *Cleaner Production Letters*, 3, 100023. <https://doi.org/10.1016/j.clpl.2022.100023>
- Galvez, J. F., Mejuto, J. C., & Simal-Gandara, J. (2018). Future challenges on the use of blockchain for food traceability analysis. *TrAC Trends in Analytical Chemistry*, 107, 222–232. <https://doi.org/10.1016/j.trac.2018.08.011>
- Gaustad, G., Krystofik, M., Bustamante, M., & Badami, K. (2018). Circular economy strategies for mitigating critical material supply issues. *Resources, Conservation and Recycling*, 135, 24–33. <https://doi.org/10.1016/j.resconrec.2017.08.002>
- Gimenez, C., & Tachizawa, E. M. (2012). Extending sustainability to suppliers: a systematic literature review. *Supply Chain Management: An International Journal*, 17(5), 531–543. <https://doi.org/10.1108/13598541211258591>
- Giusti, R., Manerba, D., Bruno, G., & Tadei, R. (2019). Synchromodal logistics: An overview of critical success factors, enabling technologies, and open research issues. *Transportation Research Part E: Logistics and Transportation Review*, 129, 92–110. <https://doi.org/10.1016/j.tre.2019.07.009>
- Gligor, D. M., & Holcomb, M. C. (2012). Understanding the role of logistics capabilities in achieving supply chain agility: a systematic literature review. *Supply Chain Management: An International Journal*, 17(4), 438–453. <https://doi.org/10.1108/13598541211246594>

- Gomez-Trujillo, A. M., Velez-Ocampo, J., & Gonzalez-Perez, M. A. (2020). A literature review on the causality between sustainability and corporate reputation. *Management of Environmental Quality: An International Journal*, 31(2), 406–430. <https://doi.org/10.1108/MEQ-09-2019-0207>
- Gorane, S. J., & Kant, R. (2015). Supply chain practices. *International Journal of Productivity and Performance Management*, 64(5), 657–685. <https://doi.org/10.1108/IJPPM-10-2013-0180>
- Grant, R. M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal*, 17(S2), 109–122. <https://doi.org/10.1002/smj.4250171110>
- Guerci, M., Montanari, F., Scapolan, A., & Epifanio, A. (2016). Green and nongreen recruitment practices for attracting job applicants: exploring independent and interactive effects. *The International Journal of Human Resource Management*, 27(2), 129–150. <https://doi.org/10.1080/09585192.2015.1062040>
- Haas, W., Krausmann, F., Wiedenhofer, D., & Heinz, M. (2015). How Circular is the Global Economy?: An Assessment of Material Flows, Waste Production, and Recycling in the European Union and the World in 2005. *Journal of Industrial Ecology*, 19(5), 765–777. <https://doi.org/10.1111/jiec.12244>
- Hair, J. F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed a Silver Bullet. *Journal of Marketing Theory and Practice*, 19(2), 139–152. <https://doi.org/10.2753/MTP1069-6679190202>

- Hauschild, S., & Knyphausen-Aufseß, D. zu. (2013). The resource-based view of diversification success: conceptual issues, methodological flaws, and future directions. *Review of Managerial Science*, 7(3), 327–363. <https://doi.org/10.1007/s11846-012-0082-0>
- Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, 43(1), 115–135. <https://doi.org/10.1007/s11747-014-0403-8>
- Henseler, J., Ringle, C. M., & Sinkovics, R. R. (2009). *The use of partial least squares path modeling in international marketing* (pp. 277–319). [https://doi.org/10.1108/S1474-7979\(2009\)0000020014](https://doi.org/10.1108/S1474-7979(2009)0000020014)
- Hoessler, C., Ellis, D. E., & Bayles, B. (2023). Managing for agility in constant change: HR strategies for teaching center leaders. *To Improve the Academy: A Journal of Educational Development*, 42(1). <https://doi.org/10.3998/tia.2092>
- Hofmann, E., & Rüsch, M. (2017). Industry 4.0 and the current status as well as future prospects on logistics. *Computers in Industry*, 89, 23–34. <https://doi.org/10.1016/j.compind.2017.04.002>
- Ivanov, D., Dolgui, A., & Sokolov, B. (2022). Cloud supply chain: Integrating Industry 4.0 and digital platforms in the “Supply Chain-as-a-Service.” *Transportation Research Part E: Logistics and Transportation Review*, 160, 102676. <https://doi.org/10.1016/j.tre.2022.102676>

- Jabbour, C. J. C., Santos, F. C. A., & Nagano, M. S. (2008). Environmental management system and human resource practices: is there a link between them in four Brazilian companies? *Journal of Cleaner Production*, 16(17), 1922–1925. <https://doi.org/10.1016/j.jclepro.2008.02.004>
- Janjarasskul, T., & Suppakul, P. (2018). Active and intelligent packaging: The indication of quality and safety. *Critical Reviews in Food Science and Nutrition*, 58(5), 808–831. <https://doi.org/10.1080/10408398.2016.1225278>
- Jin, S., Zhang, Y., & Xu, Y. (2017). Amount of information and the willingness of consumers to pay for food traceability in China. *Food Control*, 77, 163–170. <https://doi.org/10.1016/j.foodcont.2017.02.012>
- Kagermann, H. (2015). Change Through Digitization—Value Creation in the Age of Industry 4.0. In *Management of Permanent Change* (pp. 23–45). Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-05014-6_2
- Kamble, S. S., Gunasekaran, A., & Gawankar, S. A. (2020). Achieving sustainable performance in a data-driven agriculture supply chain: A review for research and applications. *International Journal of Production Economics*, 219, 179–194. <https://doi.org/10.1016/j.ijpe.2019.05.022>
- Kang, M., Yang, M. G. (Mark), Park, Y., & Huo, B. (2018). Supply chain integration and its impact on sustainability. *Industrial Management & Data Systems*, 118(9), 1749–1765. <https://doi.org/10.1108/IMDS-01-2018-0004>

- KANNAN, V. (2005). Just in time, total quality management, and supply chain management: understanding their linkages and impact on business performance. *Omega*, 33(2), 153–162. <https://doi.org/10.1016/j.omega.2004.03.012>
- Kaynak, H., & Hartley, J. L. (2008). A replication and extension of quality management into the supply chain. *Journal of Operations Management*, 26(4), 468–489. <https://doi.org/10.1016/j.jom.2007.06.002>
- Khan, M. K., Zahid, R. M. A., Shahzad, K., Hussain, M. J., & Kitendo, M. M. (2022). Role of Managerial Ability in Environmental, Social, and Economics Sustainability: An Empirical Evidence from China. *Journal of Environmental and Public Health*, 2022(1). <https://doi.org/10.1155/2022/8588385>
- Kharub, M., Mor, R. S., & Sharma, R. (2019). The relationship between cost leadership competitive strategy and firm performance. *Journal of Manufacturing Technology Management*, 30(6), 920–936. <https://doi.org/10.1108/JMTM-06-2017-0116>
- Klumpp, M., Hesenius, M., Meyer, O., Ruiner, C., & Gruhn, V. (2019). Production logistics and human-computer interaction—state-of-the-art, challenges and requirements for the future. *The International Journal of Advanced Manufacturing Technology*, 105(9), 3691–3709. <https://doi.org/10.1007/s00170-019-03785-0>
- Kouvelis, P., Chambers, C., & Wang, H. (2006). Supply Chain Management Research and *Production and Operations Management* : Review, Trends, and

- Opportunities. *Production and Operations Management*, 15(3), 449–469.
<https://doi.org/10.1111/j.1937-5956.2006.tb00257.x>
- Kraaijenbrink, J., Spender, J.-C., & Groen, A. J. (2010). The Resource-Based View: A Review and Assessment of Its Critiques. *Journal of Management*, 36(1), 349–372. <https://doi.org/10.1177/0149206309350775>
- Kuei, C., Madu, C. N., & Lin, C. (2001). The relationship between supply chain quality management practices and organizational performance. *International Journal of Quality & Reliability Management*, 18(8), 864–872.
<https://doi.org/10.1108/EUM00000000006031>
- Le, T. T., Tran, P. Q., Lam, N. P., Tra, M. N. Le, & Uyen, P. H. P. (2024). Corporate social responsibility, green innovation, environment strategy and corporate sustainable development. *Operations Management Research*, 17(1), 114–134.
<https://doi.org/10.1007/s12063-023-00411-x>
- Li, Y., Sawhne, R. S., & Wilck, J. H. (2013). Applying Bayesian Network Techniques to Prioritize Lean Six Sigma Efforts. *International Journal of Strategic Decision Sciences*, 4(2), 1–15.
<https://doi.org/10.4018/jsds.2013040101>
- Lin, C., Chow, W. S., Madu, C. N., Kuei, C.-H., & Pei Yu, P. (2005). A structural equation model of supply chain quality management and organizational performance. *International Journal of Production Economics*, 96(3), 355–365.
<https://doi.org/10.1016/j.ijpe.2004.05.009>

- Lin, J., Shen, Z., Zhang, A., & Chai, Y. (2018). Blockchain and IoT based Food Traceability for Smart Agriculture. *Proceedings of the 3rd International Conference on Crowd Science and Engineering*, 1–6. <https://doi.org/10.1145/3265689.3265692>
- Liu, L., Liu, P., Wen, F., Zhang, C., Zhao, R., Yan, M., & Yu, X. (2018). Information collection system of duck products based on IoT. *EURASIP Journal on Wireless Communications and Networking*, 2018(1), 124. <https://doi.org/10.1186/s13638-018-1144-z>
- Lorite, G. S., Selkälä, T., Sipola, T., Palenzuela, J., Jubete, E., Viñuales, A., Cabañero, G., Grande, H. J., Tuominen, J., Uusitalo, S., Hakalahti, L., Kordas, K., & Toth, G. (2017a). Novel, smart and RFID assisted critical temperature indicator for supply chain monitoring. *Journal of Food Engineering*, 193, 20–28. <https://doi.org/10.1016/j.jfoodeng.2016.06.016>
- Lorite, G. S., Selkälä, T., Sipola, T., Palenzuela, J., Jubete, E., Viñuales, A., Cabañero, G., Grande, H. J., Tuominen, J., Uusitalo, S., Hakalahti, L., Kordas, K., & Toth, G. (2017b). Novel, smart and RFID assisted critical temperature indicator for supply chain monitoring. *Journal of Food Engineering*, 193, 20–28. <https://doi.org/10.1016/j.jfoodeng.2016.06.016>
- Lozano, R., Lukman, R., Lozano, F. J., Huisingh, D., & Lambrechts, W. (2013). Declarations for sustainability in higher education: becoming better leaders, through addressing the university system. *Journal of Cleaner Production*, 48, 10–19. <https://doi.org/10.1016/j.jclepro.2011.10.006>

- Luo, H., Zhu, M., Ye, S., Hou, H., Chen, Y., & Bulysheva, L. (2016). An intelligent tracking system based on internet of things for the cold chain. *Internet Research*, 26(2), 435–445. <https://doi.org/10.1108/IntR-11-2014-0294>
- Mainetti, L., Mele, F., Patrono, L., Simone, F., Stefanizzi, M. L., & Vergallo, R. (2013). The impact of RF technologies and EPC standard on the fresh vegetables supply chain. *International Journal of RF Technologies: Research and Applications*, 5(1–2), 1–40. <https://doi.org/10.3233/RFT-130050>
- Mangla, S. K., Sharma, Y. K., Patil, P. P., Yadav, G., & Xu, J. (2019). Logistics and distribution challenges to managing operations for corporate sustainability: Study on leading Indian dairy organizations. *Journal of Cleaner Production*, 238, 117620. <https://doi.org/10.1016/j.jclepro.2019.117620>
- Mani, V., Gunasekaran, A., & Delgado, C. (2018). Enhancing supply chain performance through supplier social sustainability: An emerging economy perspective. *International Journal of Production Economics*, 195, 259–272. <https://doi.org/10.1016/j.ijpe.2017.10.025>
- Manupati, V. K., Schoenherr, T., Ramkumar, M., Wagner, S. M., Pabba, S. K., & Inder Raj Singh, R. (2020). A blockchain-based approach for a multi-echelon sustainable supply chain. *International Journal of Production Research*, 58(7), 2222–2241. <https://doi.org/10.1080/00207543.2019.1683248>
- Marrucci, L., Marchi, M., & Daddi, T. (2020). Improving the carbon footprint of food and packaging waste management in a supermarket of the Italian retail sector.

- Waste Management*, 105, 594–603.
<https://doi.org/10.1016/j.wasman.2020.03.002>
- McKinnon, A. C. (2007). Decoupling of Road Freight Transport and Economic Growth Trends in the UK: An Exploratory Analysis. *Transport Reviews*, 27(1), 37–64. <https://doi.org/10.1080/01441640600825952>
- Meidutė-Kavaliauskienė, I., Aranskis, A., & Litvinenko, M. (2014). Consumer Satisfaction with the Quality of Logistics Services. *Procedia - Social and Behavioral Sciences*, 110, 330–340.
<https://doi.org/10.1016/j.sbspro.2013.12.877>
- Mele, C., Russo Spena, T., & Colurcio, M. (2010). Co-creating value innovation through resource integration. *International Journal of Quality and Service Sciences*, 2(1), 60–78. <https://doi.org/10.1108/17566691011026603>
- Mellat-Parast, M. (2013). Supply chain quality management. *International Journal of Quality & Reliability Management*, 30(5), 511–529.
<https://doi.org/10.1108/02656711311315495>
- Mentzer, J. T., Min, S., & Michelle Bobbitt, L. (2004). Toward a unified theory of logistics. *International Journal of Physical Distribution & Logistics Management*, 34(8), 606–627. <https://doi.org/10.1108/09600030410557758>
- Mitra, S. (2016). Optimal pricing and core acquisition strategy for a hybrid manufacturing/remanufacturing system. *International Journal of Production Research*, 54(5), 1285–1302. <https://doi.org/10.1080/00207543.2015.1067376>

- Mofatteh, M. Y., Davallou, R., Ishimwe, C. N., Divekar, S. S., & Valilai, O. F. (2024). Developing a Blockchain Based Supply Chain CO2 Footprint Tracking Framework Enabled by IoT. *International Journal of Advanced Computer Science and Applications*, 15(10). <https://doi.org/10.14569/IJACSA.2024.0151002>
- Narasimhan, R., Narayanan, S., & Srinivasan, R. (2013). An Investigation of Justice in supply chain relationships and their performance impact. *Journal of Operations Management*, 31(5), 236–247. <https://doi.org/10.1016/j.jom.2013.05.001>
- Nayak, R., Akbari, M., & Maleki Far, S. (2019). Recent sustainable trends in Vietnam's fashion supply chain. *Journal of Cleaner Production*, 225, 291–303. <https://doi.org/10.1016/j.jclepro.2019.03.239>
- Ngo, V. M., Nguyen, H. H., & Nguyen, L. H. (2026). Bridging the digital divide: how technological symmetry and collaboration fortify supply chain resilience. *Operations Management Research*, 19(1), 1–26. <https://doi.org/10.1007/s12063-025-00572-x>
- Nguyen, K., Akbari, M., Quang, H. T., McDonald, S., Hoang, T.-H., Yap, T. L., & George, M. (2023). Navigating Environmental Challenges through Supply Chain Quality Management 4.0 in Circular Economy: A Comprehensive Review. *Sustainability*, 15(24), 16720. <https://doi.org/10.3390/su152416720>

- Nunes, L. J. R., & Matias, J. C. O. (2020). Biomass Torrefaction as a Key Driver for the Sustainable Development and Decarbonization of Energy Production. *Sustainability*, 12(3), 922. <https://doi.org/10.3390/su12030922>
- Oehmen, J., Ziegenbein, A., Alard, R., & Schönsleben, P. (2009). System-oriented supply chain risk management. *Production Planning & Control*, 20(4), 343–361. <https://doi.org/10.1080/09537280902843789>
- Onwuegbuzie, A. J., & Leech, N. L. (2007). A Call for Qualitative Power Analyses. *Quality & Quantity*, 41(1), 105–121. <https://doi.org/10.1007/s11135-005-1098-1>
- Óskarsdóttir, K., & Oddsson, G. V. (2019). Towards a decision support framework for technologies used in cold supply chain traceability. *Journal of Food Engineering*, 240, 153–159. <https://doi.org/10.1016/j.jfoodeng.2018.07.013>
- Pacchini, A. P. T., Lucato, W. C., Facchini, F., & Mummolo, G. (2019). The degree of readiness for the implementation of Industry 4.0. *Computers in Industry*, 113, 103125. <https://doi.org/10.1016/j.compind.2019.103125>
- Padiyar, S. V. S., Kuraie, V. C., Bhagat, N., Singh, S. R., & Chaudhary, R. (2022). An integrated inventory model for imperfect production process having preservation facilities under fuzzy and inflationary environment. *International Journal of Mathematical Modelling and Numerical Optimisation*, 12(3), 252. <https://doi.org/10.1504/IJMMNO.2022.123967>

- Pang, J., & Tan, K. H. (2018). Supply chain quality and pricing decisions under multi-manufacturer competition. *Industrial Management & Data Systems*, 118(1), 164–187. <https://doi.org/10.1108/IMDS-03-2017-0092>
- Pang, Z., Chen, Q., Han, W., & Zheng, L. (2015). Value-centric design of the internet-of-things solution for food supply chain: Value creation, sensor portfolio and information fusion. *Information Systems Frontiers*, 17(2), 289–319. <https://doi.org/10.1007/s10796-012-9374-9>
- Parast, M. M. (2019). A learning perspective of supply chain quality management: empirical evidence from US supply chains. *Supply Chain Management: An International Journal*, 25(1), 17–34. <https://doi.org/10.1108/SCM-01-2019-0028>
- Petrou, P., Demerouti, E., & Schaufeli, W. B. (2018). Crafting the Change: The Role of Employee Job Crafting Behaviors for Successful Organizational Change. *Journal of Management*, 44(5), 1766–1792. <https://doi.org/10.1177/0149206315624961>
- Piecyk, M. I., & Björklund, M. (2015). Logistics service providers and corporate social responsibility: sustainability reporting in the logistics industry. *International Journal of Physical Distribution & Logistics Management*, 45(5), 459–485. <https://doi.org/10.1108/IJPDLM-08-2013-0228>
- Piercy, N., & Rich, N. (2015). The relationship between lean operations and sustainable operations. *International Journal of Operations & Production Management*, 35(2), 282–315. <https://doi.org/10.1108/IJOPM-03-2014-0143>

- Prajogo, D. I., & Sohal, A. S. (2004). Transitioning from total quality management to total innovation management. *International Journal of Quality & Reliability Management*, 21(8), 861–875. <https://doi.org/10.1108/02656710410551746>
- Proença, D., & Borbinha, J. (2016). Maturity Models for Information Systems - A State of the Art. *Procedia Computer Science*, 100, 1042–1049. <https://doi.org/10.1016/j.procs.2016.09.279>
- Puligundla, P., Jung, J., & Ko, S. (2012). Carbon dioxide sensors for intelligent food packaging applications. *Food Control*, 25(1), 328–333. <https://doi.org/10.1016/j.foodcont.2011.10.043>
- Qian, J.-P., Yang, X.-T., Wu, X.-M., Zhao, L., Fan, B.-L., & Xing, B. (2012). A traceability system incorporating 2D barcode and RFID technology for wheat flour mills. *Computers and Electronics in Agriculture*, 89, 76–85. <https://doi.org/10.1016/j.compag.2012.08.004>
- Queiroz, M. M., & Fosso Wamba, S. (2019). Blockchain adoption challenges in supply chain: An empirical investigation of the main drivers in India and the USA. *International Journal of Information Management*, 46, 70–82. <https://doi.org/10.1016/j.ijinfomgt.2018.11.021>
- Rajeev, A., Pati, R. K., Padhi, S. S., & Govindan, K. (2017). Evolution of sustainability in supply chain management: A literature review. *Journal of Cleaner Production*, 162, 299–314. <https://doi.org/10.1016/j.jclepro.2017.05.026>

- Renwick, D. W. S., Redman, T., & Maguire, S. (2013). Green Human Resource Management: A Review and Research Agenda*. *International Journal of Management Reviews*, 15(1), 1–14. <https://doi.org/10.1111/j.1468-2370.2011.00328.x>
- Robinson, C. J., & Malhotra, M. K. (2005a). Defining the concept of supply chain quality management and its relevance to academic and industrial practice. *International Journal of Production Economics*, 96(3), 315–337. <https://doi.org/10.1016/j.ijpe.2004.06.055>
- Robinson, C. J., & Malhotra, M. K. (2005b). Defining the concept of supply chain quality management and its relevance to academic and industrial practice. *International Journal of Production Economics*, 96(3), 315–337. <https://doi.org/10.1016/j.ijpe.2004.06.055>
- Ross, J. (2017). *Total quality management: Text, cases, and readings* (3rd ed.). Taylor & Francis Group.
- Rumelt, R. P. (1984). Towards a Strategic Theory of the Firm. *Competitive Strategic Management*, 26, 556–570.
- Sarkis, J. (2003). A strategic decision framework for green supply chain management. *Journal of Cleaner Production*, 11(4), 397–409. [https://doi.org/10.1016/S0959-6526\(02\)00062-8](https://doi.org/10.1016/S0959-6526(02)00062-8)
- Sarkis, J. (2025). Corporate environmental sustainability and transitions: China's evolution and practice. In *Research Handbook on Corporate Governance in*

China (pp. 470–488). Edward Elgar Publishing.

<https://doi.org/10.4337/9781035312610.00032>

Sarkis, J., Kouhizadeh, M., & Zhu, Q. S. (2020). Digitalization and the greening of supply chains. *Industrial Management & Data Systems*, 121(1), 65–85.

<https://doi.org/10.1108/IMDS-08-2020-0450>

Satrio Wicaksono, M. G., Suryani, E., & Hendrawan, R. A. (2022). Increasing productivity of rice plants based on IoT (Internet Of Things) to realize Smart Agriculture using System Thinking approach. *Procedia Computer Science*, 197, 607–616.

<https://doi.org/10.1016/j.procs.2021.12.179>

Schmidt, M.-C., Veile, J. W., Müller, J. M., & Voigt, K.-I. (2023). Industry 4.0 implementation in the supply chain: a review on the evolution of buyer-supplier relationships. *International Journal of Production Research*, 61(17), 6063–

6080. <https://doi.org/10.1080/00207543.2022.2120923>

Schumacher, A., Erol, S., & Sihn, W. (2016). A Maturity Model for Assessing Industry 4.0 Readiness and Maturity of Manufacturing Enterprises. *Procedia CIRP*, 52, 161–166.

<https://doi.org/10.1016/j.procir.2016.07.040>

Sehnem, S., Vazquez-Brust, D., Pereira, S. C. F., & Campos, L. M. S. (2019). Circular economy: benefits, impacts and overlapping. *Supply Chain Management: An International Journal*, 24(6), 784–804.

<https://doi.org/10.1108/SCM-06-2018-0213>

- Seuring, S., & Müller, M. (2008a). From a literature review to a conceptual framework for sustainable supply chain management. *Journal of Cleaner Production*, 16(15), 1699–1710. <https://doi.org/10.1016/j.jclepro.2008.04.020>
- Seuring, S., & Müller, M. (2008b). From a literature review to a conceptual framework for sustainable supply chain management. *Journal of Cleaner Production*, 16(15), 1699–1710. <https://doi.org/10.1016/j.jclepro.2008.04.020>
- Sharma, M., Antony, R., Sharma, A., & Daim, T. (2025). Can smart supply chain bring agility and resilience for enhanced sustainable business performance? *The International Journal of Logistics Management*, 36(2), 501–555. <https://doi.org/10.1108/IJLM-09-2023-0381>
- Siems, E., Seuring, S., & Schilling, L. (2023). Stakeholder roles in sustainable supply chain management: a literature review. *Journal of Business Economics*, 93(4), 747–775. <https://doi.org/10.1007/s11573-022-01117-5>
- Singer, A. (2018). Justice Failure: Efficiency and Equality in Business Ethics. *Journal of Business Ethics*, 149(1), 97–115. <https://doi.org/10.1007/s10551-016-3086-x>
- Sirkka, A. (2008). Modelling traceability in the forestry wood supply chain. 2008 *IEEE 24th International Conference on Data Engineering Workshop*, 104–105. <https://doi.org/10.1109/ICDEW.2008.4498296>
- Soares, A., Soltani, E., & Liao, Y.-Y. (2017). The influence of supply chain quality management practices on quality performance: an empirical investigation.

- Supply Chain Management: An International Journal*, 22(2), 122–144.
<https://doi.org/10.1108/SCM-08-2016-0286>
- Sousa, R., & Voss, C. A. (2002). Quality management re-visited: a reflective review and agenda for future research. *Journal of Operations Management*, 20(1), 91–109. [https://doi.org/10.1016/S0272-6963\(01\)00088-2](https://doi.org/10.1016/S0272-6963(01)00088-2)
- Spillan, J. E., McGinnis, M. A., Kara, A., & Liu Yi, G. (2013). A comparison of the effect of logistic strategy and logistics integration on firm competitiveness in the USA and China. *The International Journal of Logistics Management*, 24(2), 153–179. <https://doi.org/10.1108/IJLM-06-2012-0045>
- Tate, T., & Warschauer, M. (2022). Equity in online learning. *Educational Psychologist*, 57(3), 192–206. <https://doi.org/10.1080/00461520.2022.2062597>
- Toriro, P., & Banhire, T. (2021). *Urban Food Markets and the Resilience Factor in Zimbabwe* (pp. 69–85). https://doi.org/10.1007/978-981-16-0305-1_5
- Tortorella, G. L., & Fettermann, D. C. (2018). Implementation of Industry 4.0 and lean production in Brazilian manufacturing companies. *International Journal of Production Research*, 56(8), 2975–2987.
<https://doi.org/10.1080/00207543.2017.1391420>
- Tsang, Y. P., Choy, K. L., Wu, C. H., Ho, G. T. S., Lam, C. H. Y., & Koo, P. S. (2018). An Internet of Things (IoT)-based risk monitoring system for managing cold supply chain risks. *Industrial Management & Data Systems*, 118(7), 1432–1462. <https://doi.org/10.1108/IMDS-09-2017-0384>

- Tsang, Y. P., Choy, K. L., Wu, C. H., Ho, G. T. S., & Lam, H. Y. (2019). Blockchain-Driven IoT for Food Traceability With an Integrated Consensus Mechanism. *IEEE Access*, 7, 129000–129017. <https://doi.org/10.1109/ACCESS.2019.2940227>
- Tsai, T. P., & Wang, F.-C. (2004). Improving supply chain management: A model for collaborative quality control. In *Proceedings of the IEEE/SEMI Advanced Semiconductor Manufacturing Conference and Workshop* (pp. 36–42). IEEE. <https://doi.org/10.1109/ASMC.2004.1309531>
- Tuni, A., & Rentizelas, A. (2022). Improving environmental sustainability in agri-food supply chains: Evidence from an eco-intensity-based method application. *Cleaner Logistics and Supply Chain*, 5, 100081. <https://doi.org/10.1016/j.clscn.2022.100081>
- Turcu, C. (Ed.). (2010). *Sustainable Radio Frequency Identification Solutions*. InTech. <https://doi.org/10.5772/174>
- Vachon, S., & Klassen, R. D. (2006). Extending green practices across the supply chain. *International Journal of Operations & Production Management*, 26(7), 795–821. <https://doi.org/10.1108/01443570610672248>
- Vachon, S., & Klassen, R. D. (2008). Environmental management and manufacturing performance: The role of collaboration in the supply chain. *International Journal of Production Economics*, 111(2), 299–315. <https://doi.org/10.1016/j.ijpe.2006.11.030>

- Van Nguyen, T., Pham, H. T., Ha, H. M., & Tran, T. T. T. (2024). An integrated model of supply chain quality management, Industry 3.5 and innovation to improve manufacturers' performance – a case study of Vietnam. *International Journal of Logistics Research and Applications*, 27(2), 261–283. <https://doi.org/10.1080/13675567.2022.2059457>
- Vanderroost, M., Ragaert, P., Devlieghere, F., & De Meulenaer, B. (2014). Intelligent food packaging: The next generation. *Trends in Food Science & Technology*, 39(1), 47–62. <https://doi.org/10.1016/j.tifs.2014.06.009>
- Vanichchinchai, A., & Igel, B. (2009). Total quality management and supply chain management: similarities and differences. *The TQM Journal*, 21(3), 249–260. <https://doi.org/10.1108/17542730910953022>
- Verdouw, C. N., Robbemon, R. M., Verwaart, T., Wolfert, J., & Beulens, A. J. M. (2018). A reference architecture for IoT-based logistic information systems in agri-food supply chains. *Enterprise Information Systems*, 12(7), 755–779. <https://doi.org/10.1080/17517575.2015.1072643>
- Vilariño, M. V., Franco, C., & Quarrington, C. (2017). Food loss and Waste Reduction as an Integral Part of a Circular Economy. *Frontiers in Environmental Science*, 5. <https://doi.org/10.3389/fenvs.2017.00021>
- Vuong, T. K., Lam, T. N., & Bui, H. M. (2024). Sustainable Consumer Behaviour in the Fast-Moving Consumer Goods Sector: Moderating Role of Competitive Intensity in Green Marketing. *Business Strategy & Development*, 7(4). <https://doi.org/10.1002/bsd2.70047>

- Wang, J., Liu, G., Liu, H., & Lam, P. K. S. (2017). Multivariate statistical evaluation of dissolved trace elements and a water quality assessment in the middle reaches of Huaihe River, Anhui, China. *Science of The Total Environment*, 583, 421–431. <https://doi.org/10.1016/j.scitotenv.2017.01.088>
- Wang, M. (2018). Impacts of supply chain uncertainty and risk on the logistics performance. *Asia Pacific Journal of Marketing and Logistics*, 30(3), 689–704. <https://doi.org/10.1108/APJML-04-2017-0065>
- Wernerfelt, B. (1984). The RBV of the Firm. *Strategic Management Journal*, 5(2), 171–180. <https://www.jstor.org/stable/2486175>
- Wieland, A., Handfield, R. B., & Durach, C. F. (2016). Mapping the Landscape of Future Research Themes in Supply Chain Management. *Journal of Business Logistics*, 37(3), 205–212. <https://doi.org/10.1111/jbl.12131>
- Wiengarten, F., Pagell, M., Ahmed, M. U., & Gimenez, C. (2014). Do a country's logistical capabilities moderate the external integration performance relationship? *Journal of Operations Management*, 32(1–2), 51–63. <https://doi.org/10.1016/j.jom.2013.07.001>
- World Bank Group. (2025). *Population World Bank 2025*.
- Xiao, S. (2023). Retraction Note: Research on the information security of sharing economy customers based on block chain technology. *Information Systems and E-Business Management*, 21(S1), 21–21. <https://doi.org/10.1007/s10257-022-00596-x>

- Xiao, T., Yang, D., & Shen, H. (2011). Coordinating a supply chain with a quality assurance policy via a revenue-sharing contract. *International Journal of Production Research*, 49(1), 99–120. <https://doi.org/10.1080/00207543.2010.508936>
- Xu, X., Lu, Y., Vogel-Heuser, B., & Wang, L. (2021). Industry 4.0 and Industry 5.0—Inception, conception and perception. *Journal of Manufacturing Systems*, 61, 530–535. <https://doi.org/10.1016/j.jmsy.2021.10.006>
- Xu, Z., Ge, Z., Wang, X., & Skare, M. (2021). Bibliometric analysis of technology adoption literature published from 1997 to 2020. *Technological Forecasting and Social Change*, 170, 120896. <https://doi.org/10.1016/j.techfore.2021.120896>
- Yan, R. (2017). Optimization approach for increasing revenue of perishable product supply chain with the Internet of Things. *Industrial Management & Data Systems*, 117(4), 729–741. <https://doi.org/10.1108/IMDS-07-2016-0297>
- Yoo, S. H., Kim, D., & Park, M.-S. (2015). Pricing and return policy under various supply contracts in a closed-loop supply chain. *International Journal of Production Research*, 53(1), 106–126. <https://doi.org/10.1080/00207543.2014.932927>
- Yusuf, Y. Y., Musa, A., Dauda, M., El-Berishy, N., Kovvuri, D., & Abubakar, T. (2014). A study of the diffusion of agility and cluster competitiveness in the oil and gas supply chains. *International Journal of Production Economics*, 147, 498–513. <https://doi.org/10.1016/j.ijpe.2013.04.010>

- Zeng, J., Anh Phan, C., & Matsui, Y. (2015). The impact of hard and soft quality management on quality and innovation performance: An empirical study. *International Journal of Production Economics*, 162, 216–226. <https://doi.org/10.1016/j.ijpe.2014.07.006>
- Zhao, X., Huo, B., Flynn, B. B., & Yeung, J. H. Y. (2008). The impact of power and relationship commitment on the integration between manufacturers and customers in a supply chain. *Journal of Operations Management*, 26(3), 368–388. <https://doi.org/10.1016/j.jom.2007.08.002>
- Zheng, T., Ardolino, M., Bacchetti, A., & Perona, M. (2021). The applications of Industry 4.0 technologies in manufacturing context: a systematic literature review. *International Journal of Production Research*, 59(6), 1922–1954. <https://doi.org/10.1080/00207543.2020.1824085>
- Zhu, Q., Geng, Y., Sarkis, J., & Lai, K. H. (2014). Barriers to promoting eco-Industrial parks development in China: Perspectives from senior officials at National Industrial Parks. *Journal of Industrial Ecology*, 19(3), 457–467. <https://doi.org/10.1111/jiec.12176>
- Zhu, Q., Sarkis, J., & Lai, K. (2008). Green supply chain management implications for “closing the loop.” *Transportation Research Part E: Logistics and Transportation Review*, 44(1), 1–18. <https://doi.org/10.1016/j.tre.2006.06.003>
- Zhu, Q., Sarkis, J., & Lai, K. (2012). Green supply chain management innovation diffusion and its relationship to organizational improvement: An ecological modernization perspective. *Journal of Engineering and Technology*

Management, 29(1), 168–185.

<https://doi.org/10.1016/j.jengtecman.2011.09.012>

Zimon, D., Tyan, J., & Sroufe, R. (2019). Implementing Sustainable Supply Chain Management: Reactive, Cooperative, and Dynamic Models. *Sustainability*, 11(24), 7227. <https://doi.org/10.3390/su11247227>

Zu, X., Robbins, T. L., & Fredendall, L. D. (2010). Mapping the critical links between organizational culture and TQM/Six Sigma practices. *International Journal of Production Economics*, 123(1), 86–106. <https://doi.org/10.1016/j.ijpe.2009.07.009>

Appendix 1 – Proposed Questionnaire

Dear Sir/Madam,

We are a research team from SSBM (Swiss School of Business and Management), conducting a study on Supply Chain Quality Management 4.0 (SCQM 4.0) and its impact on sustainable development in the FMCG industry in Vietnam. We look forward to receiving your review and feedback on the following questionnaire. Your responses through this survey will be highly valuable for the success of our research. We are committed to keeping the information you provide confidentially and only using it for the purpose of thesis research.

If you wish to receive a summary of the research findings, please leave your email address:.....

The survey will take approximately 10-15 minutes to complete. Thank you very much for taking the time to support us.

PHẦN 1: THÔNG TIN CÔNG TY

SECTION 1: COMPANY INFORMATION

1. Loại hình doanh nghiệp:

- | | | |
|---|--|--|
| ☐ TNHH | ☐ Doanh nghiệp tư nhân (thuộc sở hữu cá nhân) | ☐ Tập đoàn, Công ty |
| ☐ Công ty nhà nước | ☐ Liên doanh | ☐ Công ty 100% |
| ☐ Cổ Phần | | |
| ☐ Công ty vốn nước ngoài | | |

1. Business Type:

- | | | |
|--|---|--|
| ☐ Private Limited Company | ☐ Sole Proprietorship (Individually Owned) | ☐ Corporation / |
| ☐ Joint-Stock Company | ☐ Joint Venture | ☐ Wholly Foreign- |
| ☐ State-Owned Enterprise | | |
| ☐ Owned Company | | |

2. Số lượng nhân viên:

- | | |
|---|---|
| ☐ Dưới 10 người | ☐ Từ 10 đến 200 người |
| ☐ Từ 200 đến 300 người | ☐ Từ 300 đến 1,000 người |
| ☐ Trên 1,000 người | |

2. Workforce Size:

- | | |
|--|--|
| ☐ Less than 10 employees | ☐ 10 – 200 employees |
| ☐ 200 – 300 employees | ☐ 300 – 1,000 employees |
| ☐ More than 1,000 employees | |

3. Lĩnh vực hoạt động chính:

- | | |
|---|--|
| ☐ Sản xuất sản phẩm ngành hàng tiêu dùng nhanh | ☐ SX, kinh doanh sản phẩm ngành hàng tiêu dùng nhanh và phân phối nguyên vật liệu |
| ☐ Kinh doanh sản phẩm ngành hàng tiêu dùng nhanh | ☐ Phân phối nguyên vật liệu ngành hàng tiêu dùng nhanh |
| ☐ SX và kinh doanh sản phẩm ngành hàng tiêu dùng nhanh | |

3. Main Business Operations:

- | | |
|---|--|
| ☐ FMCG Product Manufacturing | ☐ Manufacturing, Trading, and Raw Material Distribution |
| ☐ FMCG Product Trading | ☐ FMCG Raw Material Distribution |
| ☐ FMCG Product Manufacturing & Trading | |

4. Vốn điều lệ:

- | | | |
|--|--|--|
| ☐ Dưới 20 tỷ đồng | ☐ Từ 20 tỷ - 100 tỷ đồng | ☐ Từ 100 tỷ - 300 tỷ đồng |
| ☐ Từ 300 tỷ - 500 tỷ đồng | ☐ Từ 500 tỷ - 1,000 tỷ đồng | ☐ Trên 1,000 tỷ đồng |

4. Registered Capital:

- | | | |
|--|---|--|
| ☐ Below 20 billion VND | ☐ 20 – 100 billion VND | ☐ 100 – 300 billion VND |
| ☐ 300 – 500 billion VND | ☐ 500 billion – 1 trillion VND | ☐ Above 1 trillion VND |

5. Thời gian hoạt động:

- | | |
|---|--|
| ☐ Ít hơn 1 năm | ☐ Từ 1 – 3 năm |
| ☐ Từ 3 – 5 năm | ☐ Từ 5 – 10 năm |
| ☐ Từ 10 – 15 năm | ☐ Trên 15 năm |

5. Years in Operation:

- | | |
|---|--------------------------------------|
| ☐ Less than 1 year | ☐ 1 – 3 years |
|---|--------------------------------------|

☐ 3 – 5 years
 ☐ 5 – 10 years
 ☐ 10 – 15 years
 ☐ More than 15 years

6. Đối tượng khách hàng chính của Quý công ty:
☐ Doanh nghiệp (B2B)
 ☐ Cá thể (B2C)
 ☐ Cả 2 (B2B & B2C)

6. Primary Customer Base:
☐ Business-to-Business (B2B)
 ☐ Business-to-Consumer (B2C)
 ☐ Both (B2B & B2C)

7. Chức vụ của Quý Ông / Bà?
☐ Chủ tịch
 ☐ Phó chủ tịch
 ☐ Giám đốc
 ☐ Trưởng phòng
 ☐ Quản lý
 ☐ Nhân viên (điều phối)
 ☐ Khác:

7. Your Job Title:
☐ Chairman
 ☐ Vice Chairman
 ☐ Director
 ☐ Department Head
 ☐ Manager
 ☐ Staff
 ☐ Other (please specify):

8. Bộ phận làm việc:
☐ Kinh Doanh
 ☐ Tiếp Thị / Thương mại
 ☐ Quản lý dự án
 ☐ Sản xuất/ Vận hành
 ☐ Quản lý chất lượng
 ☐ Kế hoạch
 ☐ Kho vận
 ☐ Mua hàng
 ☐ Quản lý chuỗi cung ứng
 ☐ R&D
 ☐ Tài chính / Kế toán
 ☐ Khác:

8. Your Department:
☐ Sales & Business Development Management
 ☐ Marketing / Trade
 ☐ Project
 ☐ Production & Operations
 ☐ Quality Management
 ☐ Planning
 ☐ Warehousing & Logistics Management
 ☐ Procurement
 ☐ Supply Chain
 ☐ Customer Service
 ☐ Research & Development (R&D)
 ☐ Finance / Accounting
 ☐ Other (please specify):

9. Cấu trúc tổ chức của Chuỗi cung ứng, bao gồm các hoạt động nào sau đây: (Được chọn nhiều lựa chọn):
☐ Kế hoạch
 ☐ Mua hàng
 ☐ Kho Vận
 ☐ Chăm sóc khách hàng
 ☐ Sản xuất
 ☐ Quản lý Chất lượng (QA, QC)
 ☐ Phát triển bền vững (Sustainability)
 ☐ An toàn, Sức khỏe, Môi trường (SHE)
 ☐ Khác:.....

9. Which supply chain functions does your company manage? (Multiple choices)
☐ Planning
 ☐ Procurement
 ☐ Warehousing & Logistics
 ☐ Customer Service
 ☐ Production
 ☐ Quality Assurance / Quality Control (QA/QC)
 ☐ Sustainability Development
 ☐ Safety, Health, and Environment (SHE)
 ☐ Other (please specify):

10. Bộ phận Quản lý Chuỗi cung ứng, báo cáo cho cấp quản lý nào sau đây (Được chọn nhiều lựa chọn):
☐ CEO / Tổng Giám Đốc
 ☐ Giám đốc Vận hành (Operation Director)
 ☐ Giám đốc Tài chính
 ☐ Báo cáo theo chiều dọc lên Regional/Global
 ☐ Khác:.....

10. Supply Chain Management (SCM) report to (Multiple choices):
☐ Chief Executive Officer (CEO)
 ☐ Operation Director
 ☐ Chief Financial Officer (CFO)
 ☐ Regional/Global Reporting
 ☐ Other (please specify):

11. Bộ phận Quản lý chất lượng (tổng thể), báo cáo cho cấp quản lý nào sau đây (Được chọn nhiều lựa chọn):
☐ CEO / Tổng Giám Đốc
 ☐ Giám đốc Chuỗi cung ứng (Supply Chain Director)
 ☐ Giám đốc Vận hành (Operation Director)
 ☐ Báo cáo theo chiều dọc lên Regional/Global
 ☐ Khác:.....

11. General Quality Management report to (Multiple choices):

- ☐ Chief Executive Officer (CEO) ☐ Supply Chain Director
☐ Operation Director ☐ Regional/Global Reporting ☐ Other (please specify): _____

12. Bộ phận Quản lý Công nghệ thông tin (IT), Chuyển đổi số, báo cáo cho cấp quản lý nào sau đây (Được chọn nhiều lựa chọn):

- ☐ CEO / Tổng Giám Đốc ☐ Giám đốc Tài Chính
☐ Giám đốc Nhân sự (HR) ☐ Báo cáo theo chiều dọc lên Regional/Global ☐ Khác: _____

12. IT & Digital Transformation report to (Multiple choices):

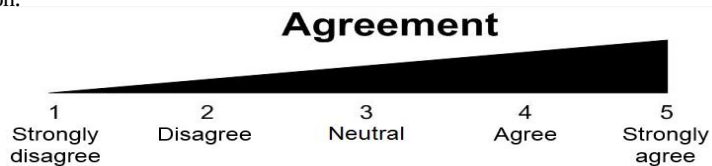
- ☐ Chief Executive Officer (CEO) ☐ Chief Financial Officer (CFO)
☐ Chief Human Resources Officer (CHRO) ☐ Regional/Global Reporting ☐ Other (please specify): _____

PHẦN 2: THỰC HIỆN QUẢN LÝ CHẤT LƯỢNG CHUỖI CUNG ỨNG 4.0

SECTION 2: SUPPLY CHAIN QUALITY MANAGEMENT 4.0 IMPLEMENTATION

Quý Ông/ Bà vui lòng thể hiện mức độ đồng ý của mình với các phát biểu liên quan đến các hoạt động chất lượng trong chuỗi cung ứng của quý công ty theo quy ước sau:

Please indicate your level of agreement with the following statements regarding quality practices in your company's supply chain according to the following convention:



		Hoàn toàn không đồng ý / Totally Disagree		Trung lập/ Neutral	Hoàn toàn đồng ý / Totally Agree	
1	Ban lãnh đạo hiểu tầm quan trọng của việc thực hiện công nghệ. / Leadership understands the critical importance of technology implementation.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
2	Ban lãnh đạo đưa ra chiến lược triển khai, chính sách để áp dụng các công nghệ mới. / Leadership establishes deployment strategies and policies to adopt emerging technologies.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
3	Ban lãnh đạo cung cấp các nguồn lực cần thiết để áp dụng các công nghệ mới. / Leadership provides the necessary resources to enable the adoption of new technologies.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
4	Ban lãnh đạo tham gia, chịu trách nhiệm vào việc áp dụng và cải tiến công nghệ. / Leadership actively participates and takes responsibility in the adoption and continuous improvement of technology.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
5	Ban lãnh đạo tích cực thể hiện cam kết liên tục áp dụng các công nghệ mới. / Leadership demonstrates strong commitment to the continuous adoption of new technologies.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
6	Mục tiêu phát triển nhân viên của công ty bắt nguồn từ các mục tiêu chiến lược. / Employee development objectives are aligned with the company's strategic goals.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
7	Cơ cấu tổ chức tập trung vào việc áp dụng các công nghệ mới. / The organizational structure is designed to prioritize the adoption of new technologies.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
8	Chiến lược nguồn nhân lực tạo điều kiện môi trường thuận lợi cho nhân viên học hỏi và trao nhiều quyền hơn để ứng dụng công nghệ mới trong công việc. / The human resource strategy fosters a supportive environment for employees to learn and empowers them to apply new technologies in their work.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

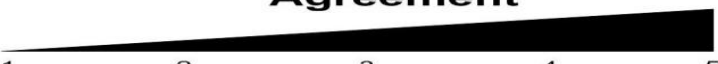
9	Công ty động viên để nhân viên áp dụng công nghệ mới. / The company motivates employees to adopt new technologies.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
10	Các nhân viên và các nhà quản lý trực tiếp xác định nhu cầu đào tạo để hiểu và áp dụng các công nghệ mới. / Employees and direct managers identify training needs to understand and apply new technologies.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
11	Cơ sở hạ tầng và tài nguyên CNTT của công ty được trang bị từ ban đầu dự án. / The company's IT infrastructure and resources are equipped from the start of the project.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
12	Cơ sở hạ tầng CNTT của công ty hỗ trợ phát triển và triển khai các công nghệ mới. / The company's IT infrastructure supports the development and deployment of new technologies.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
13	Cơ sở hạ tầng của công ty có thể lưu trữ khối lượng dữ liệu khổng lồ. / The company's infrastructure is capable of storing massive volumes of data.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
14	Nhân viên của công ty sẵn sàng ứng dụng công nghệ mới vào công việc. / Employees are ready to integrate new technologies into their daily work.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
15	Công ty đã đưa ra một hệ thống khen thưởng để khuyến khích việc áp dụng các công nghệ mới. / The company has introduced a reward system to encourage the adoption of new technologies.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
16	Nhân viên hiểu được tầm quan trọng của việc áp dụng công nghệ mới. / Employees understand the importance of adopting new technologies.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
17	Nhân viên hiểu những khó khăn khi áp dụng công nghệ mới. / Employees are aware of the challenges of implementing new technologies.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
18	Nhân viên tin rằng việc áp dụng công nghệ mới sẽ có tác động tích cực đến công việc của họ. / Employees believe that adopting new technologies will have a positive impact on their work.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
19	Các đối tác của công ty hiểu những lợi ích của việc áp dụng công nghệ mới. / The company's partners understand the benefits of adopting new technologies.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
20	Các đối tác trong chuỗi cung ứng của công ty và các đối tác trao đổi thông tin kịp thời. / The company's supply chain partners and partners exchange information in a timely manner.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
21	Các đối tác trong chuỗi cung ứng của công ty và các đối tác trao đổi thông tin chính xác. / The company's supply chain partners and partners exchange accurate information.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
22	Công ty duy trì liên lạc chặt chẽ với các đối tác thương mại chính của công ty về các cân nhắc chất lượng. / The company maintains close communication with its key business partners regarding quality considerations.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
23	Công ty chia sẻ lợi ích, rủi ro và phần thưởng trong việc nâng cao chất lượng chuỗi cung ứng với các đối tác thương mại chính của công ty. / The company shares benefits, risks, and rewards in enhancing supply chain quality with its key business partners.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
24	Công ty đã giúp các đối tác thương mại của công ty cải thiện chất lượng sản phẩm của họ. / The company has helped its business partners improve their product quality.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
25	Công ty có các mục tiêu chung và phù hợp đã được thống nhất với các đối tác thương mại chính của công ty. / The company has established common and aligned goals with its key business partners.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
26	Công ty phát triển mối quan hệ lâu dài và tin cậy với các đối tác thương mại. / The company develops long-term and trustworthy relationships with its business partners.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

27	Công ty sử dụng hiệu quả các nguồn lực. / The company effectively utilizes resources.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
28	Công ty có khả năng thích ứng và phản ứng nhanh trước những thay đổi từ môi trường kinh doanh và thị trường. / The company adapts to environmental changes. The company reacts quickly to market changes.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
29	Công ty linh hoạt với các yêu cầu thay đổi liên tục của khách hàng. / The company is flexible with customers' continuously changing demands.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
30	Áp lực cạnh tranh từ thị trường trong nước khiến công ty tăng cường ứng dụng công nghệ 4.0 để tối ưu chi phí và rút ngắn thời gian giao hàng. / Local competitive pressure leads the firm to strengthen the use of Industry 4.0 technologies to optimize costs and shorten delivery times.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
31	Sự cạnh tranh giữa các doanh nghiệp địa phương thúc đẩy công ty áp dụng các giải pháp số hóa về công nghệ 4.0 nhằm cải thiện chất lượng dịch vụ và đáp ứng nhanh nhu cầu khách hàng nội địa. / Competition among domestic firms drives the company to adopt digital Industry 4.0 solutions to improve service quality and respond quickly to local customer needs.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
32	Áp lực cạnh tranh toàn cầu buộc công ty triển khai các công nghệ 4.0 để tuân thủ chuẩn mực quốc tế và nâng cao tính minh bạch trong chuỗi cung ứng. / Global competitive pressure compels the firm to implement Industry 4.0 technologies to comply with international standards and enhance supply chain transparency.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
33	Sự cạnh tranh từ các đối thủ quốc tế thúc đẩy công ty mở rộng ứng dụng Industry 4.0 để tăng khả năng hội nhập và duy trì vị thế trên thị trường toàn cầu. / Competition from international rivals pushes the firm to expand Industry 4.0 adoption to increase integration and sustain its position in global markets.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
34	Công ty có thiết lập quy trình, dữ liệu, hệ thống Quản lý Chất lượng (tổng thể). / The company has established processes, data, and a Total Quality Management System.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
35	Công ty có thiết lập quy trình, dữ liệu, hệ thống Quản lý Chuỗi cung ứng. / The company has established processes, data, and a Supply Chain Management System.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
36	Công ty có thiết lập quy trình, dữ liệu, hệ thống Quản lý Công nghệ thông tin / Chuyển đổi số. / The company has established processes, data, and an IT Management / Digital Transformation System.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
37	Công ty có sử dụng các công cụ trong Quản lý chất lượng tổng thể vào hoạt động Quản lý vận hành Chuỗi cung ứng. / The company applies Total Quality Management tools to Supply Chain Management operations.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
38	Nhìn chung, Anh Chị đánh giá việc Quản lý chất lượng Chuỗi cung ứng 4.0 là tốt, hiệu quả giúp nâng cao mức độ phục vụ khách hàng với chi phí tối ưu. / Overall, you assess Supply Chain Quality Management 4.0 as good and effective, helping to improve customer service levels with optimal costs.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

PHẦN 3: ÁP DỤNG CÔNG NGHỆ 4.0

SECTION 3: INDUSTRY 4.0 TECHNOLOGY ADOPTION

Đánh giá mức độ thực hiện các công nghệ dưới đây của Quý công ty:
Rate your company's implementation of the following technologies:

Agreement 						
1 2 3 4 5 Do not apply Few applications Some departments apply Many departments apply All departments apply						
		Không áp dụng / Not applicable			Tất cả các phòng ban áp dụng / All departments apply	
1	Robotics	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
2	Công nghệ in 3D (3D printing technology)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
3	Công nghệ đám mây (Cloud technologies)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
4	Công nghệ blockchain (Block chain technology)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
5	Công nghệ Hệ thống Vật lý Mạng / Cyber-Physical Systems (CPS)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
6	Lập kế hoạch nguồn lực doanh nghiệp / Enterprise Resource Planning (ERP)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
7	Nhận dạng tần số vô tuyến / Radio Frequency Identification (RFID)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
8	Giao tiếp ngữ nghĩa giữa máy với máy (Semantic Machine-to-Machine (M2M) Communication)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
9	Internet vạn vật / Internet of Things (IoT)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
10	Phân tích dữ liệu lớn / Big Data Analytics (BDA)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
11	Trí tuệ nhân tạo / Artificial Intelligence (AI)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
12	Nhìn chung, Anh Chị đánh giá mức độ áp dụng công nghệ mới vào thực tế công việc của các phòng ban / Overall, how would you assess the level of new technology adoption across different business functions?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

PHẦN 4: PHÁT TRIỂN BỀN VỮNG

SECTION 4: SUSTAINABILITY DEVELOPMENT

Quý Ông / Bà vui lòng thể hiện mức độ đồng ý với các phát biểu dưới đây về ảnh hưởng của các công nghệ nêu trên lên sự phát triển bền vững của công ty bằng cách đánh dấu (X) vào ô từ 1 đến 5: Please indicate your level of agreement with the following statements regarding the impact of the above technologies on the company's sustainable development by marking (X) in boxes 1 to 5:						
		Hoàn toàn không đồng ý / Totally Disagree		Trung lập / Neutral	Hoàn toàn đồng ý / Totally Agree	
1	Công ty có thiết lập quy trình, dữ liệu, hệ thống quản lý Phát triển bền vững. / The company has established processes, data, and a Sustainability Management System.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
2	Công ty có truyền thông về tầm quan trọng và lợi ích của việc Phát triển bền vững. / The company communicates the importance and benefits of Sustainable Development.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

	3	Nhân viên trong công ty có hiểu biết và tham gia vào các hoạt động Phát triển bền vững. / Employees in the company understand and participate in Sustainability Initiatives.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
H1	4	Các quy trình sản xuất sạch hơn trong nội bộ và tiết kiệm năng lượng tác động tích cực đến hiệu quả môi trường thông qua việc giảm phát thải và sử dụng tài nguyên hiệu quả. / Internal cleaner production and energy-saving practices positively affect environmental performance through reduced emissions and efficient resource utilization.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
H1	5	Việc xây dựng hạ tầng CNTT và hệ thống quản lý chất thải trong nội bộ nâng cao hiệu quả môi trường thông qua việc tối ưu xử lý, tái chế và giám sát dữ liệu môi trường. / IT infrastructure and internal waste management systems enhance environmental performance through optimized treatment, recycling, and environmental data monitoring.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
H1	6	Sự tham gia và cam kết của lãnh đạo trong áp dụng công nghệ xanh tác động đến hiệu quả môi trường thông qua việc thúc đẩy đổi mới bền vững. / Leadership commitment to adopting green technologies impacts environmental performance through fostering sustainable innovation.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
	7	Công ty tăng cường sử dụng năng lượng tái tạo trong các hoạt động phân phối. / The company increases the use of renewable energy in distribution activities.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
H2	8	Việc xây dựng văn hóa tổ chức và trao quyền cho nhân viên nâng cao hiệu quả xã hội thông qua việc thúc đẩy sự gắn kết và cam kết của nhân viên. / Building organizational culture and employee empowerment enhance social performance through greater engagement and commitment.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
H2	9	Chính sách phúc lợi và đào tạo nội bộ tác động tích cực đến hiệu quả xã hội thông qua việc nâng cao an toàn, sức khỏe và sự hài lòng của nhân viên. / Internal welfare and training policies positively affect social performance through improved safety, health, and employee satisfaction.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
	10	Điều kiện làm việc của công ty thì an toàn. / The company ensures safe working conditions.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
	11	Không có sự phân biệt đối xử tại công ty. / There is no discrimination in the company.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
	12	Không sử dụng lao động trẻ em và lao động cưỡng bức tại công ty. / The company does not employ child labor or forced labor.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
H2	13	Sự sẵn sàng của nhân viên trong việc áp dụng công nghệ mới tác động đến hiệu quả xã hội thông qua việc cải thiện kỹ năng và giảm rủi ro nghề nghiệp. / Employee readiness to adopt new technologies affects social performance through improved skills and reduced occupational risks.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
	14	Công ty tuân thủ đạo đức kinh doanh. / The company adheres to business ethics.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
H3	15	Việc áp dụng công nghệ số và hệ thống quản lý tích hợp trong nội bộ nâng cao hiệu quả kinh tế thông qua việc gia tăng năng suất và hiệu quả sử dụng tài nguyên. / Adoption of digital technologies and integrated management systems internally enhances economic performance through increased productivity and resource efficiency.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
H3	16	Cơ sở hạ tầng CNTT mạnh mẽ tác động đến hiệu quả kinh tế thông qua việc cải thiện tốc độ xử lý và hỗ trợ các quyết định kinh doanh kịp thời. / Robust IT infrastructure impacts economic performance through improved processing speed and timely business decision-making.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

H3	17	Việc nâng cao năng lực và kỹ năng tổ chức của nhân sự giúp doanh nghiệp tối ưu hóa hiệu quả kinh tế thông qua việc giảm chi phí lao động và nâng cao năng suất làm việc. / Enhancing employees' capabilities and organizational skills enables the company to optimize economic performance by reducing labor costs and improving productivity.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
H4	18	Việc tuân thủ các tiêu chuẩn môi trường quốc tế nâng cao hiệu quả môi trường thông qua việc giảm thiểu rủi ro và đáp ứng yêu cầu toàn cầu. / Compliance with international environmental standards enhances environmental performance through risk reduction and global requirement fulfillment.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
H4	19	Chia sẻ dữ liệu môi trường với các đối tác trong chuỗi cung ứng tác động đến hiệu quả môi trường thông qua việc cải thiện minh bạch và giám sát bền vững. / Sharing environmental data with supply chain partners affects environmental performance through improved transparency and sustainable monitoring.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
H4	20	Hợp tác với nhà cung cấp xanh tác động tích cực đến hiệu quả môi trường thông qua việc giảm tác động trong chuỗi cung ứng. / Collaboration with green suppliers positively affects environmental performance through reduced supply chain impacts.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
H5	21	Việc tham gia vào các chương trình trách nhiệm xã hội cùng đối tác tác động đến hiệu quả xã hội thông qua việc nâng cao hình ảnh doanh nghiệp. / Participation in joint CSR programs with partners affects social performance through improved corporate image.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
H5	22	Minh bạch thông tin với khách hàng và đối tác tác động tích cực đến hiệu quả xã hội thông qua việc xây dựng lòng tin và uy tín. / Transparency with customers and partners positively impacts social performance through trust and reputation building.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
H5	23	Hợp tác chặt chẽ với cộng đồng địa phương và các đối tác thương mại nâng cao hiệu quả xã hội thông qua việc tạo giá trị chung. / Close collaboration with local communities and business partners enhances social performance through shared value creation.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
	24	Công ty tạo ra các mạng lưới hậu cần năng động. / The company creates dynamic logistics networks.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
	25	Công ty có khả năng phân phối lớn hơn do giảm thời gian giao hàng thông qua hệ thống vận chuyển nhanh hơn. / The company has greater distribution capacity due to shorter delivery times through faster transportation systems.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
H6	26	Áp lực cạnh tranh toàn cầu thúc đẩy công ty mở rộng ứng dụng công nghệ 4.0 để tác động đến hiệu quả kinh tế thông qua việc tối ưu chi phí và duy trì vị thế thị trường. / Global competitive pressure drives the firm to expand Industry 4.0 adoption to affecting economic performance through cost optimization and sustained market position.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
H6	27	Hợp tác chiến lược với đối tác kinh doanh cải thiện hiệu quả kinh tế thông qua việc chia sẻ nguồn lực và lợi ích. / Strategic collaboration with business partners improves economic performance through resource and benefit sharing.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
H6	28	Việc mở rộng thị trường nhờ liên kết với đối tác quốc tế tác động đến hiệu quả kinh tế thông qua việc tiếp cận khách hàng mới và tăng doanh thu. / Market expansion through international partnerships affects economic performance through access to new customers and increased revenue.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

	29	Nhìn chung, Anh Chị đánh giá việc áp dụng các yếu tố trong “Phát triển bền vững” nêu trên mang lại kết quả tốt thực tế trong hoạt động kinh doanh, xã hội, môi trường. / Overall, you assess that the adoption of the above Sustainability Development elements has delivered real, positive outcomes in business operations, society, and the environment.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
--	----	---	----------------------------	----------------------------	----------------------------	----------------------------	----------------------------

Xin chân thành cảm ơn sự hợp tác của Quý Ông / Bà!
Thank you very much for your cooperation!

Appendix 2 – List of Expert for Deep Interview

No.	First Name	Last Name	Job Title	Company
1	Hoang Anh	Nguyen	Head of Production	P&G
2	Hien Anh Tuan	Le	Director of Supply Chain	Unilever
3	Thi Mai	Le	Procurement Manager	Bitis
4	Van Hieu	Nguyen	Toal Quality Management (TQM) Director	Thien Long group
5	Nam	Hoang	Human Resources Director	Vinamilk
6	Thi Tam Doan	Nguyen	Planning Lead	Massan
7	Thanh Hai	Tran	Quality Assurance Head	Acecook
8	Nam Cuong	Nguyen	R&D Director	Vissan
9	Thi Truc Li	Nguyen	CFO	Suntory Pepsico
10	Tan Bao	Truong	IT Director	TH True milk
11	Dang Khoa	Nguyen	Logistics Manager	Ajinomoto
12	Tat Thanh	Ngo	Customer Service Head	CJ Food Vietnam
13	Huu Khanh	Tran	Operations Director	URC Vietnam
14	Thi Ngoc Quynh	Pham	Trade Marketing Manager	Nestle
15	Tien Luc	Dinh	Business Development Lead	TTC
16	Quoc Dat	Nguyen	Regulatory Affairs Manager	BAT Vietnam

Appendix 3 – Expert Invitation Email Forms

Dear Mr. XXXXXXXX – Former Deputy Head of the Management XXXXXXXX

My name is Quang Le Trong Bang, and I am currently conducting research on the topic “Supply Chain Quality Management 4.0 For Sustainable Performance Excellence In FMCG Companies” under the guidance of Prof. Dr. Saša Petar, Ph.D. The project focuses on evaluating the practices impacting the sustainable performance excellence of FMCG Companies in Vietnam in Industrial Technology Evolution 4.0 environment.

I would like to invite Mr./Ms. to participate in an in-depth interview to develop a research framework for my research thesis. The conversation will revolve around the following main points:

How to measurement: Supply Chain Quality Management Practices 4.0; Industrial 4.0 Technology Adoption; and Sustainability Developed Performance Excellence of FMCG Vietnam companies?

How do Supply Chain Quality Management Practices 4.0 effect to Sustainability Developed Performance Excellence in the positive way?

What role does Industrial 4.0 Technology Adoption play in the relationship between Supply Chain Quality Management Practices 4.0 and Sustainability Developed Performance Excellence in FMCG Vietnam land scape?

All information collected will only be used for scientific research purposes and will be kept strictly confidential. If you agree, I would greatly appreciate your response regarding a suitable time to schedule an interview (in person or online via Zoom/Google Meet). I can send detailed documents in advance for your reference if needed.

Thank you very much for your valuable support. I would greatly appreciate your response via Zalo or phone number 0913xxxxxxx

Sincerely,

QUANG LE TRONG BANG

May 20, 2025.

Appendix 4 – Questionnaire after Interview

Dear Sir/Madam,

We are a research team from SSBM (Swiss School of Business and Management), conducting a study on Supply Chain Quality Management 4.0 (SCQM 4.0) and its impact on sustainable development in the FMCG industry in Vietnam. We look forward to receiving your review and feedback on the following questionnaire. Your responses through this survey will be highly valuable for the success of our research. We are committed to keeping the information you provide confidentially and only using it for the purpose of thesis research.

If you wish to receive a summary of the research findings, please leave your email address:.....

The survey will take approximately 10-15 minutes to complete. Thank you very much for taking the time to support us.

PHẦN 1: THÔNG TIN CÔNG TY

SECTION 1: COMPANY INFORMATION

1. Loại hình doanh nghiệp:

- | | | |
|---|--|--|
| ☐ TNHH | ☐ Doanh nghiệp tư nhân (thuộc sở hữu cá nhân) | ☐ Tập đoàn, Công ty |
| ☐ Công ty nhà nước | ☐ Liên doanh | ☐ Công ty 100% |
| ☐ Công ty vốn nước ngoài | | |

1. Business Type:

- | | | |
|--|---|--|
| ☐ Private Limited Company | ☐ Sole Proprietorship (Individually Owned) | ☐ Corporation / |
| ☐ Joint-Stock Company | ☐ Joint Venture | ☐ Wholly Foreign- |
| ☐ State-Owned Enterprise | | |
| ☐ Owned Company | | |

2. Đối tượng khách hàng chính của Quý công ty:

- | | | |
|---|---------------------------------------|---|
| ☐ Doanh nghiệp (B2B) | ☐ Cá thể (B2C) | ☐ Cả 2 (B2B & B2C) |
|---|---------------------------------------|---|

2. Primary Customer Base:

- | | | |
|---|---|---|
| ☐ Business-to-Business (B2B) | ☐ Business-to-Consumer (B2C) | ☐ Both (B2B & B2C) |
|---|---|---|

PHẦN 2: THỰC HIỆN QUẢN LÝ CHẤT LƯỢNG CHUỖI CUNG ỨNG 4.0

SECTION 2: SUPPLY CHAIN QUALITY MANAGEMENT 4.0 IMPLEMENTATION

Quý Ông/ Bà vui lòng thể hiện mức độ đồng ý của mình với các phát biểu liên quan đến các hoạt động chất lượng trong chuỗi cung ứng của quý công ty theo quy ước sau: Please indicate your level of agreement with the following statements regarding quality practices in your company's supply chain according to the following convention:					
Agreement					
		Hoàn toàn không đồng ý / Totally Disagree		Hoàn toàn đồng ý / Totally Agree	
1	Ban lãnh đạo hiểu tầm quan trọng của việc thực hiện công nghệ. / Leadership understands the critical importance of technology implementation.	☐ 1	☐ 2	☐ 3	☐ 4 ☐ 5

2	Ban lãnh đạo đưa ra chiến lược triển khai, chính sách để áp dụng các công nghệ mới. / Leadership establishes deployment strategies and policies to adopt emerging technologies.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
3	Ban lãnh đạo cung cấp các nguồn lực cần thiết để áp dụng các công nghệ mới. / Leadership provides the necessary resources to enable the adoption of new technologies.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
4	Ban lãnh đạo tham gia, chịu trách nhiệm vào việc áp dụng và cải tiến công nghệ. / Leadership actively participates and takes responsibility in the adoption and continuous improvement of technology.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
5	Ban lãnh đạo tích cực thể hiện cam kết liên tục áp dụng các công nghệ mới. / Leadership demonstrates strong commitment to the continuous adoption of new technologies.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
6	Mục tiêu phát triển nhân viên của công ty bắt nguồn từ các mục tiêu chiến lược. / Employee development objectives are aligned with the company's strategic goals.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
7	Cơ cấu tổ chức tập trung vào việc áp dụng các công nghệ mới. / The organizational structure is designed to prioritize the adoption of new technologies.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
8	Chiến lược nguồn nhân lực tạo điều kiện môi trường thuận lợi cho nhân viên học hỏi và trao nhiều quyền hơn để ứng dụng công nghệ mới trong công việc. / The human resource strategy fosters a supportive environment for employees to learn and empowers them to apply new technologies in their work.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
9	Công ty động viên để nhân viên áp dụng công nghệ mới. / The company motivates employees to adopt new technologies.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
10	Các nhân viên và các nhà quản lý trực tiếp xác định nhu cầu đào tạo để hiểu và áp dụng các công nghệ mới. / Employees and direct managers identify training needs to understand and apply new technologies.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
11	Cơ sở hạ tầng và tài nguyên CNTT của công ty được trang bị từ ban đầu dự án. / The company's IT infrastructure and resources are equipped from the start of the project.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
12	Cơ sở hạ tầng CNTT của công ty hỗ trợ phát triển và triển khai các công nghệ mới. / The company's IT infrastructure supports the development and deployment of new technologies.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
13	Cơ sở hạ tầng của công ty có thể lưu trữ khối lượng dữ liệu khổng lồ. / The company's infrastructure is capable of storing massive volumes of data.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
14	Nhân viên của công ty sẵn sàng ứng dụng công nghệ mới vào công việc. / Employees are ready to integrate new technologies into their daily work.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
15	Công ty đã đưa ra một hệ thống khen thưởng để khuyến khích việc áp dụng các công nghệ mới. / The company has introduced a reward system to encourage the adoption of new technologies.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
16	Nhân viên hiểu được tầm quan trọng của việc áp dụng công nghệ mới. / Employees understand the importance of adopting new technologies.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
17	Nhân viên hiểu những khó khăn khi áp dụng công nghệ mới. / Employees are aware of the challenges of implementing new technologies.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
18	Nhân viên tin rằng việc áp dụng công nghệ mới sẽ có tác động tích cực đến công việc của họ. / Employees believe that adopting new technologies will have a positive impact on their work.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
19	Các đối tác của công ty hiểu những lợi ích của việc áp dụng công nghệ mới. / The company's partners understand the benefits of adopting new technologies.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

20	Các đối tác trong chuỗi cung ứng của công ty và các đối tác trao đổi thông tin kịp thời. / The company's supply chain partners and partners exchange information in a timely manner.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
21	Các đối tác trong chuỗi cung ứng của công ty và các đối tác trao đổi thông tin chính xác. / The company's supply chain partners and partners exchange accurate information.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
22	Công ty duy trì liên lạc chặt chẽ với các đối tác thương mại chính của công ty về các cân nhắc chất lượng. / The company maintains close communication with its key business partners regarding quality considerations.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
23	Công ty chia sẻ lợi ích, rủi ro và phần thưởng trong việc nâng cao chất lượng chuỗi cung ứng với các đối tác thương mại chính của công ty. / The company shares benefits, risks, and rewards in enhancing supply chain quality with its key business partners.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
24	Công ty đã giúp các đối tác thương mại của công ty cải thiện chất lượng sản phẩm của họ. / The company has helped its business partners improve their product quality.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
25	Công ty có các mục tiêu chung và phù hợp đã được thống nhất với các đối tác thương mại chính của công ty. / The company has established common and aligned goals with its key business partners.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
26	Công ty phát triển mối quan hệ lâu dài và tin cậy với các đối tác thương mại. / The company develops long-term and trustworthy relationships with its business partners.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
27	Công ty sử dụng hiệu quả các nguồn lực. / The company effectively utilizes resources.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
28	Công ty có khả năng thích ứng và phản ứng nhanh trước những thay đổi từ môi trường kinh doanh và thị trường. / The company adapts to environmental changes. The company reacts quickly to market changes.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
29	Công ty linh hoạt với các yêu cầu thay đổi liên tục của khách hàng. / The company is flexible with customers' continuously changing demands.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
30	Áp lực cạnh tranh từ thị trường trong nước khiến công ty tăng cường ứng dụng công nghệ 4.0 để tối ưu chi phí và rút ngắn thời gian giao hàng. / Local competitive pressure leads the firm to strengthen the use of Industry 4.0 technologies to optimize costs and shorten delivery times.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
31	Sự cạnh tranh giữa các doanh nghiệp địa phương thúc đẩy công ty áp dụng các giải pháp số hóa về công nghệ 4.0 nhằm cải thiện chất lượng dịch vụ và đáp ứng nhanh nhu cầu khách hàng nội địa. / Competition among domestic firms drives the company to adopt digital Industry 4.0 solutions to improve service quality and respond quickly to local customer needs.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
32	Áp lực cạnh tranh toàn cầu buộc công ty triển khai các công nghệ 4.0 để tuân thủ chuẩn mực quốc tế và nâng cao tính minh bạch trong chuỗi cung ứng. / Global competitive pressure compels the firm to implement Industry 4.0 technologies to comply with international standards and enhance supply chain transparency.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
33	Sự cạnh tranh từ các đối thủ quốc tế thúc đẩy công ty mở rộng ứng dụng Industry 4.0 để tăng khả năng hội nhập và duy trì vị thế trên thị trường toàn cầu. / Competition from international rivals pushes the firm to expand Industry 4.0 adoption to increase integration and sustain its position in global markets.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
34	Công ty có thiết lập quy trình, dữ liệu, hệ thống Quản lý Chất lượng (tổng thể). / The company has established processes, data, and a Total Quality Management System.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

35	Công ty có thiết lập quy trình, dữ liệu, hệ thống Quản lý Chuỗi cung ứng. / The company has established processes, data, and a Supply Chain Management System.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
36	Công ty có thiết lập quy trình, dữ liệu, hệ thống Quản lý Công nghệ thông tin / Chuyên đổi số. / The company has established processes, data, and an IT Management / Digital Transformation System.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
37	Công ty có sử dụng các công cụ trong Quản lý chất lượng tổng thể vào hoạt động Quản lý vận hành Chuỗi cung ứng. / The company applies Total Quality Management tools to Supply Chain Management operations.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
38	Nhìn chung, Anh Chị đánh giá việc Quản lý chất lượng Chuỗi cung ứng 4.0 là tốt, hiệu quả giúp nâng cao mức độ phục vụ khách hàng với chi phí tối ưu. / Overall, you assess Supply Chain Quality Management 4.0 as good and effective, helping to improve customer service levels with optimal costs.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

PHẦN 3: ÁP DỤNG CÔNG NGHỆ 4.0

SECTION 3: INDUSTRY 4.0 TECHNOLOGY ADOPTION

Đánh giá mức độ thực hiện các công nghệ dưới đây của Quý công ty:
Rate your company's implementation of the following technologies:

Agreement

1 2 3 4 5

Do not Few Some Many All
apply applications departments departments departments
apply apply apply

		Không áp dụng / Not applicable			Tất cả các phòng ban áp dụng / All departments apply
1	Robotics	☐ 1	☐ 2	☐ 3	☐ 4 ☐ 5
2	Công nghệ in 3D (3D printing technology)	☐ 1	☐ 2	☐ 3	☐ 4 ☐ 5
3	Công nghệ đám mây (Cloud technologies)	☐ 1	☐ 2	☐ 3	☐ 4 ☐ 5
4	Công nghệ blockchain (Block chain technology)	☐ 1	☐ 2	☐ 3	☐ 4 ☐ 5
5	Công nghệ Hệ thống Vật lý Mạng / Cyber-Physical Systems (CPS)	☐ 1	☐ 2	☐ 3	☐ 4 ☐ 5
6	Lập kế hoạch nguồn lực doanh nghiệp / Enterprise Resource Planning (ERP)	☐ 1	☐ 2	☐ 3	☐ 4 ☐ 5
7	Nhận dạng tần số vô tuyến / Radio Frequency Identification (RFID)	☐ 1	☐ 2	☐ 3	☐ 4 ☐ 5
8	Giao tiếp ngữ nghĩa giữa máy với máy (Semantic Machine-to-Machine (M2M) Communication)	☐ 1	☐ 2	☐ 3	☐ 4 ☐ 5
9	Internet vạn vật / Internet of Things (IoT)	☐ 1	☐ 2	☐ 3	☐ 4 ☐ 5
10	Phân tích dữ liệu lớn / Big Data Analytics (BDA)	☐ 1	☐ 2	☐ 3	☐ 4 ☐ 5
11	Trí tuệ nhân tạo / Artificial Intelligence (AI)	☐ 1	☐ 2	☐ 3	☐ 4 ☐ 5
12	Nhìn chung, Anh Chị đánh giá mức độ áp dụng công nghệ mới vào thực tế công việc của các phòng ban / Overall, how would you assess the level of new technology adoption across different business functions?	☐ 1	☐ 2	☐ 3	☐ 4 ☐ 5

PHẦN 4: PHÁT TRIỂN BỀN VỮNG
SECTION 4: SUSTAINABILITY DEVELOPMENT

Quý Ông / Bà vui lòng thể hiện mức độ đồng ý với các phát biểu dưới đây về ảnh hưởng của các công nghệ nêu trên lên sự phát triển bền vững của công ty bằng cách đánh dấu (X) vào ô từ 1 đến 5:
Please indicate your level of agreement with the following statements regarding the impact of the above technologies on the company's sustainable development by marking (X) in boxes 1 to 5:

Agreement

		1	2	3	4	5
		Do not apply	Few applications	Some departments apply	Many departments apply	All departments apply
		Hoàn toàn không đồng ý / Totally Disagree Trung lập/ Neutral Hoàn toàn đồng ý / Totally Agree				
1	Công ty có thiết lập quy trình, dữ liệu, hệ thống quản lý Phát triển bền vững . / The company has established processes, data, and a Sustainability Management System.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
2	Công ty có truyền thông về tầm quan trọng và lợi ích của việc Phát triển bền vững. / The company communicates the importance and benefits of Sustainable Development.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
3	Nhân viên trong công ty có hiểu biết và tham gia vào các hoạt động Phát triển bền vững. / Employees in the company understand and participate in Sustainability Initiatives.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
4	Các quy trình sản xuất sạch hơn trong nội bộ và tiết kiệm năng lượng tác động tích cực đến hiệu quả môi trường thông qua việc giảm phát thải và sử dụng tài nguyên hiệu quả. / Internal cleaner production and energy-saving practices positively affect environmental performance through reduced emissions and efficient resource utilization.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
5	Việc xây dựng hạ tầng CNTT và hệ thống quản lý chất thải trong nội bộ nâng cao hiệu quả môi trường thông qua việc tối ưu xử lý, tái chế và giám sát dữ liệu môi trường. / IT infrastructure and internal waste management systems enhance environmental performance through optimized treatment, recycling, and environmental data monitoring.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
6	Sự tham gia và cam kết của lãnh đạo trong áp dụng công nghệ xanh tác động đến hiệu quả môi trường thông qua việc thúc đẩy đổi mới bền vững. / Leadership commitment to adopting green technologies impacts environmental performance through fostering sustainable innovation.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
7	Công ty tăng cường sử dụng năng lượng tái tạo trong các hoạt động phân phối. / The company increases the use of renewable energy in distribution activities.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
8	Việc xây dựng văn hóa tổ chức và trao quyền cho nhân viên nâng cao hiệu quả xã hội thông qua việc thúc đẩy sự gắn kết và cam kết của nhân viên. / Building organizational culture and employee empowerment enhance social performance through greater engagement and commitment.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
9	Chính sách phúc lợi và đào tạo nội bộ tác động tích cực đến hiệu quả xã hội thông qua việc nâng cao an toàn, sức khỏe và sự hài lòng của nhân viên. / Internal welfare and training policies positively affect social performance through improved safety, health, and employee satisfaction.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

10	Điều kiện làm việc của công ty thì an toàn. / The company ensures safe working conditions.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
11	Không có sự phân biệt đối xử tại công ty. / There is no discrimination in the company.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
12	Không sử dụng lao động trẻ em và lao động cưỡng bức tại công ty. / The company does not employ child labor or forced labor.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
13	Sự sẵn sàng của nhân viên trong việc áp dụng công nghệ mới tác động đến hiệu quả xã hội thông qua việc cải thiện kỹ năng và giảm rủi ro nghề nghiệp. / Employee readiness to adopt new technologies affects social performance through improved skills and reduced occupational risks.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
14	Công ty tuân thủ đạo đức kinh doanh. / The company adheres to business ethics.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
15	Việc áp dụng công nghệ số và hệ thống quản lý tích hợp trong nội bộ nâng cao hiệu quả kinh tế thông qua việc gia tăng năng suất và hiệu quả sử dụng tài nguyên. / Adoption of digital technologies and integrated management systems internally enhances economic performance through increased productivity and resource efficiency.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
16	Cơ sở hạ tầng CNTT mạnh mẽ tác động đến hiệu quả kinh tế thông qua việc cải thiện tốc độ xử lý và hỗ trợ các quyết định kinh doanh kịp thời. / Robust IT infrastructure impacts economic performance through improved processing speed and timely business decision-making.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
17	Việc nâng cao năng lực và kỹ năng tổ chức của nhân sự giúp doanh nghiệp tối ưu hóa hiệu quả kinh tế thông qua việc giảm chi phí lao động và nâng cao năng suất làm việc. / Enhancing employees' capabilities and organizational skills enables the company to optimize economic performance by reducing labor costs and improving productivity.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
18	Việc tuân thủ các tiêu chuẩn môi trường quốc tế nâng cao hiệu quả môi trường thông qua việc giảm thiểu rủi ro và đáp ứng yêu cầu toàn cầu. / Compliance with international environmental standards enhances environmental performance through risk reduction and global requirement fulfillment.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
19	Chia sẻ dữ liệu môi trường với các đối tác trong chuỗi cung ứng tác động đến hiệu quả môi trường thông qua việc cải thiện minh bạch và giám sát bền vững. / Sharing environmental data with supply chain partners affects environmental performance through improved transparency and sustainable monitoring.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
20	Hợp tác với nhà cung cấp xanh tác động tích cực đến hiệu quả môi trường thông qua việc giảm tác động trong chuỗi cung ứng. / Collaboration with green suppliers positively affects environmental performance through reduced supply chain impacts.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
21	Việc tham gia vào các chương trình trách nhiệm xã hội cùng đối tác tác động đến hiệu quả xã hội thông qua việc nâng cao hình ảnh doanh nghiệp. / Participation in joint CSR programs with partners affects social performance through improved corporate image.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
22	Minh bạch thông tin với khách hàng và đối tác tác động tích cực đến hiệu quả xã hội thông qua việc xây dựng lòng tin và uy tín. / Transparency with customers and partners positively impacts social performance through trust and reputation building.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
23	Hợp tác chặt chẽ với cộng đồng địa phương và các đối tác thương mại nâng cao hiệu quả xã hội thông qua việc tạo giá trị chung. / Close collaboration with local communities and business partners enhances social performance through shared value creation.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
24	Công ty tạo ra các mạng lưới hậu cần năng động. / The company creates dynamic logistics networks.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

25	Công ty có khả năng phân phối lớn hơn do giảm thời gian giao hàng thông qua hệ thống vận chuyển nhanh hơn. / The company has greater distribution capacity due to shorter delivery times through faster transportation systems.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
26	Áp lực cạnh tranh toàn cầu thúc đẩy công ty mở rộng ứng dụng công nghệ 4.0 để tác động đến hiệu quả kinh tế thông qua việc tối ưu chi phí và duy trì vị thế thị trường. / Global competitive pressure drives the firm to expand Industry 4.0 adoption to affecting economic performance through cost optimization and sustained market position.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
27	Hợp tác chiến lược với đối tác kinh doanh cải thiện hiệu quả kinh tế thông qua việc chia sẻ nguồn lực và lợi ích. / Strategic collaboration with business partners improves economic performance through resource and benefit sharing.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
28	Việc mở rộng thị trường nhờ liên kết với đối tác quốc tế tác động đến hiệu quả kinh tế thông qua việc tiếp cận khách hàng mới và tăng doanh thu. / Market expansion through international partnerships affects economic performance through access to new customers and increased revenue.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
29	Nhìn chung, Anh Chị đánh giá việc áp dụng các yếu tố trong “Phát triển bền vững” nêu trên mang lại kết quả tốt thực tế trong hoạt động kinh doanh, xã hội, môi trường. / Overall, you assess that the adoption of the above Sustainability Development elements has delivered real, positive outcomes in business operations, society, and the environment.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

Xin chân thành cảm ơn sự hợp tác của Quý Ông / Bà!
Thank you very much for your cooperation!

Appendix 5 – Cronbach's Alpha Results

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,908	,908	5

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
TMS1	16,7052	8,745	,748	,616	,892
TMS2	16,8765	8,533	,786	,672	,884
TMS3	16,9721	7,947	,820	,679	,876
TMS4	16,9880	8,268	,765	,612	,888
TMS5	16,9363	8,468	,725	,553	,897

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,854	,855	5

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
HR1	16,3546	7,766	,611	,376	,838
HR2	16,7331	7,244	,637	,421	,834
HR3	16,5378	7,186	,722	,541	,810
HR4	16,3745	7,195	,724	,562	,809
HR5	16,5339	7,706	,650	,448	,829

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,839	,841	3

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
IT1	8,1633	3,281	,667	,497	,811
IT2	7,9442	3,061	,792	,629	,692
IT3	7,9641	3,123	,657	,474	,825

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,900	,904	5

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
AW1	16,2789	10,706	,772	,611	,873
AW2	16,5976	10,369	,671	,464	,901
AW3	16,2709	10,630	,833	,712	,861
AW4	16,2629	11,083	,753	,614	,878
AW5	16,1833	11,166	,759	,601	,877

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,872	,872	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
IS1	11,9084	5,988	,661	,462	,862
IS2	12,0279	5,363	,779	,612	,815
IS3	12,0000	5,592	,774	,612	,818
IS4	11,7769	5,894	,695	,516	,849

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,954	,954	16

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
CP1	62,1833	99,838	,726	,667	,951
CP2	62,0199	99,700	,747	,707	,950
CP3	61,9920	100,880	,702	,641	,951
CP4	61,8048	103,062	,688	,554	,951
CP5	62,1116	103,548	,637	,493	,952
CP6	61,9920	100,968	,746	,670	,950
CP7	61,9402	101,672	,673	,603	,952
CP8	61,9363	101,060	,733	,652	,951
CP9	61,9044	100,415	,773	,714	,950
CP10	61,8127	99,497	,789	,729	,949
CP11	61,7849	101,146	,739	,640	,950
CP12	61,8367	100,225	,748	,680	,950
CP13	61,8606	99,832	,806	,781	,949
CP14	61,8805	99,938	,788	,760	,949
CP15	61,9323	100,655	,730	,676	,951
CP16	61,8446	103,172	,674	,495	,952

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,881	,881	12

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
ITI1	32,7171	93,716	,627	,502	,869
ITI2	33,7450	99,495	,497	,647	,876
ITI3	31,8247	98,233	,515	,359	,875
ITI4	33,6135	97,246	,558	,641	,873
ITI5	32,1394	96,360	,535	,494	,874
ITI6	31,5259	102,210	,415	,409	,880
ITI7	33,3028	96,044	,520	,384	,876
ITI8	33,4502	95,073	,606	,608	,870
ITI9	32,8367	91,033	,706	,598	,864
ITI10	32,2629	92,795	,708	,684	,864
ITI11	32,4661	93,554	,678	,642	,866
ITI12	32,1713	100,687	,573	,395	,873

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,869	,868	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
OA1	12,0359	4,955	,772	,605	,812
OA2	11,9721	4,955	,802	,666	,798
OA3	12,0996	5,266	,775	,621	,810
OA4	11,9044	6,871	,566	,322	,889

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,850	,851	6

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
EVP1	19,9283	11,579	,741	,593	,804
EVP2	20,0000	11,656	,680	,516	,816
EVP3	19,8725	11,792	,709	,514	,811
EVP4	20,2072	12,837	,472	,293	,856
EVP5	19,7371	12,307	,599	,490	,831
EVP6	19,7371	12,299	,613	,525	,829

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,915	,916	10

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
SP1	38,8207	34,316	,680	,626	,908
SP2	38,7769	34,094	,709	,635	,906
SP3	38,4980	34,803	,743	,585	,904
SP4	38,5618	34,359	,657	,521	,909
SP5	38,2749	35,992	,626	,464	,910
SP6	38,7928	34,853	,661	,450	,909
SP7	38,3865	36,494	,640	,478	,910
SP8	38,6295	34,066	,762	,648	,902
SP9	38,6534	34,811	,702	,583	,906
SP10	38,6733	35,013	,710	,623	,906

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,897	,896	9

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
EP1	32,7092	24,767	,623	,504	,888
EP2	32,6255	23,419	,722	,662	,880
EP3	32,7809	23,604	,719	,646	,880
EP4	32,6733	23,757	,723	,599	,880
EP5	32,9721	26,219	,413	,350	,903
EP6	32,9920	24,960	,563	,450	,893
EP7	32,6972	23,908	,713	,663	,881
EP8	32,6932	23,622	,757	,684	,878
EP9	32,7410	23,681	,708	,583	,881

Appendix 6 – Exploration Factor Analysis Results

1st EFE Result:

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,954
Bartlett's Test of Sphericity	Approx. Chi-Square df	8155,465 703
	Sig.	0,000

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	20,149	53,023	53,023	20,149	53,023	53,023	6,439	16,946	16,946
2	1,815	4,776	57,799	1,815	4,776	57,799	5,208	13,707	30,652
3	1,319	3,472	61,271	1,319	3,472	61,271	4,956	13,042	43,694
4	1,168	3,075	64,346	1,168	3,075	64,346	4,592	12,083	55,778
5	1,008	2,653	66,999	1,008	2,653	66,999	4,264	11,221	66,999
6	,927	2,439	69,438						
7	,847	2,229	71,667						
8	,790	2,079	73,746						
9	,743	1,956	75,702						
10	,689	1,812	77,514						
11	,672	1,768	79,282						
12	,633	1,665	80,947						
13	,591	1,556	82,503						
14	,534	1,406	83,908						
15	,501	1,317	85,226						
16	,442	1,163	86,388						
17	,429	1,129	87,517						
18	,390	1,026	88,544						
19	,377	,993	89,536						
20	,355	,934	90,470						
21	,338	,889	91,359						
22	,317	,835	92,194						
23	,287	,755	92,949						
24	,269	,708	93,657						

25	,262	,689	94,346					
26	,232	,611	94,957					
27	,221	,582	95,539					
28	,211	,555	96,094					
29	,197	,518	96,612					
30	,190	,500	97,112					
31	,181	,477	97,588					
32	,170	,449	98,037					
33	,158	,417	98,454					
34	,145	,382	98,836					
35	,142	,373	99,209					
36	,107	,281	99,490					
37	,104	,273	99,763					
38	,090	,237	100,000					

Extraction Method: Principal Component Analysis.

Rotated Component Matrix^a

	Component				
	1	2	3	4	5
TMS1	,670				
TMS2	,724				
TMS3	,784				
TMS4	,721				
TMS5	,708				
HR1					
HR2					
HR3	,608				
HR4	,632				
HR5	,594				
IT1					,570
IT2					,653
IT3					,664
AW1				,587	
AW2		,515			
AW3				,664	
AW4				,628	
AW5				,681	
IS1				,618	

IS2					
IS3					
IS4					
CP1		,670			
CP2		,678			
CP3		,696			
CP4		,598			
CP5		,564			
CP6					
CP7		,567			
CP8			,564		
CP9			,654		
CP10			,663		
CP11			,628		
CP12			,558		
CP13			,600		
CP14			,506		,583
CP15					,631
CP16					

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 13 iterations.

2nd EFA Results:

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,951
Bartlett's Test of Sphericity	Approx. Chi-Square	6168,758
	df	435
	Sig.	0,000

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	16,119	53,731	53,731	16,119	53,731	53,731	6,542	21,806	21,806
2	1,664	5,547	59,278	1,664	5,547	59,278	5,759	19,196	41,002
3	1,206	4,020	63,298	1,206	4,020	63,298	4,317	14,390	55,391
4	1,028	3,425	66,723	1,028	3,425	66,723	3,400	11,332	66,723
5	,960	3,200	69,923						
6	,790	2,634	72,557						
7	,749	2,498	75,055						
8	,664	2,213	77,268						
9	,643	2,145	79,413						
10	,574	1,913	81,326						
11	,522	1,740	83,066						
12	,479	1,595	84,661						
13	,424	1,414	86,075						
14	,406	1,352	87,427						
15	,396	1,321	88,748						
16	,384	1,278	90,027						
17	,337	1,122	91,149						
18	,316	1,053	92,202						
19	,268	,892	93,094						
20	,250	,832	93,926						
21	,241	,802	94,729						
22	,230	,766	95,495						
23	,222	,741	96,236						
24	,210	,698	96,934						
25	,195	,651	97,586						
26	,187	,622	98,208						
27	,168	,561	98,769						
28	,134	,448	99,216						
29	,125	,418	99,634						
30	,110	,366	100,000						

Extraction Method: Principal Component Analysis.

Rotated Component Matrixa

	Component			
	1	2	3	4
TMS1		,694		
TMS2		,740		
TMS3		,809		
TMS4		,725		
TMS5		,719		
HR3		,597		
HR4		,645		
HR5		,589		
IT1				,667
IT2				,685
IT3				,686
AW1	,628			
AW2	,602			
AW3	,706			
AW4	,683			
AW5	,675			
IS1	,580			
CP1	,626			
CP2	,647			
CP3	,670			
CP4	,656			
CP5	,570			
CP7	,591			
CP8			,616	
CP9			,699	
CP10			,692	
CP11			,662	
CP12			,590	
CP13			,601	
CP15			,505	,579

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 8 iterations.

3rd EFA Results:

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	,951
Bartlett's Test of Sphericity	Approx. Chi-Square
	5880,726
	df
	406
	Sig.
	0,000

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	15,609	53,825	53,825	15,609	53,825	53,825	6,240	21,516	21,516
2	1,625	5,603	59,428	1,625	5,603	59,428	5,589	19,273	40,790
3	1,141	3,933	63,361	1,141	3,933	63,361	4,462	15,387	56,177
4	1,009	3,479	66,840	1,009	3,479	66,840	3,092	10,663	66,840
5	,936	3,228	70,068						
6	,753	2,597	72,665						
7	,745	2,567	75,232						
8	,658	2,270	77,502						
9	,640	2,207	79,709						
10	,571	1,970	81,679						
11	,500	1,726	83,405						
12	,472	1,627	85,032						
13	,423	1,459	86,491						
14	,398	1,372	87,863						
15	,388	1,338	89,201						
16	,352	1,213	90,414						
17	,321	1,105	91,519						
18	,314	1,084	92,603						
19	,266	,917	93,520						
20	,244	,841	94,362						
21	,234	,808	95,169						
22	,228	,786	95,956						
23	,220	,759	96,715						
24	,203	,699	97,414						
25	,192	,662	98,076						
26	,172	,593	98,669						
27	,138	,477	99,146						

28	,134	,463	99,609						
29	,113	,391	100,000						

Extraction Method: Principal Component Analysis.

Rotated Component Matrix^a

	Component			
	1	2	3	4
TMS1		,704		
TMS2		,746		
TMS3		,793		
TMS4		,718		
TMS5		,717		
HR3		,584		
HR4		,659		
HR5		,567		
IT1				,716
IT2				,678
IT3				,621
AW1	,651			
AW2	,582			
AW3	,737			
AW4	,707			
AW5	,716			
IS1	,605			
CP1	,584			
CP2	,610			
CP3	,626			
CP4	,631			
CP5	,527			
CP7	,545			
CP8			,649	
CP9			,727	
CP10			,710	
CP11			,698	
CP12			,590	
CP13			,613	

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization. a. Rotation converged in 7 iterations.

Appendix 7: 1st & 2nd Research Question – SEM Analysis on Smart-PLS 3.0

1st Model:

R Square

	R Square	R Square Adjusted
SDP	0,623	0,617

f Square

	CP	CR	IT	SDP	SS
CP				0,120	
CR				0,031	
IT				0,026	
SDP					
SS				0,011	

Construct Reliability and Validity

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
CP	0,921	0,923	0,938	0,717
CR	0,939	0,940	0,947	0,598
IT	0,841	0,850	0,904	0,759
SDP	0,961	0,965	0,964	0,485
SS	0,924	0,925	0,938	0,653

Discriminant Validity

Fornell-Larcker

Criterion

	CP	CR	IT	SDP	SS
CP	0,847				
CR	0,799	0,773			
IT	0,728	0,732	0,871		
SDP	0,756	0,716	0,669	0,697	
SS	0,751	0,746	0,674	0,664	0,808

Path Coefficients – Bootstrapping

Mean, STDEV, T-Values, P-Values

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
CP -> SDP	0,399	0,399	0,073	5,491	0,000
CR -> SDP	0,202	0,205	0,078	2,598	0,009
IT -> SDP	0,159	0,155	0,063	2,509	0,012
SS -> SDP	0,107	0,110	0,070	1,533	0,125

2nd Model – Overall Awareness

R Square

	R Square	R Square Adjusted
OA	0,415	0,406

f Square

	CP	CR	IT	OA	SS
CP				0,053	
CR				0,013	
IT				0,022	
OA					
SS				0,001	

Construct Reliability and Validity

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
CP	0,921	0,926	0,938	0,717
CR	0,939	0,940	0,947	0,598
IT	0,841	0,855	0,904	0,758
OA	0,868	0,869	0,911	0,719
SS	0,924	0,927	0,938	0,653

Discriminant Validity

Fornell-Larcker

Criterion

	CP	CR	IT	OA	SS
CP	0,847				
CR	0,799	0,773			
IT	0,731	0,733	0,871		
OA	0,615	0,581	0,562	0,848	
SS	0,749	0,743	0,671	0,520	0,808

Path Coefficients – Bootstrapping

Mean, STDEV, T-Values, P-Values

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
CP -> OA	0,331	0,328	0,102	3,254	0,001
CR -> OA	0,161	0,166	0,090	1,797	0,072
IT -> OA	0,182	0,174	0,088	2,054	0,040
SS -> OA	0,031	0,040	0,090	0,344	0,731

3rd Model – Economy Performance

R Square

	R Square	R Square Adjusted
EP	0,525	0,517

f Square

	CP	CR	EP	IT	SS
CP			0,118		
CR			0,003		
EP					
IT			0,013		
SS			0,017		

Construct Reliability and Validity

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
CP	0,921	0,922	0,938	0,718
CR	0,939	0,940	0,947	0,598
EP	0,896	0,911	0,916	0,555
IT	0,841	0,845	0,905	0,760
SS	0,924	0,924	0,938	0,653

Discriminant Validity

Fornell-Larcker Criterion

	CP	CR	EP	IT	SS
CP	0,847				
CR	0,798	0,773			
EP	0,704	0,630	0,745		
IT	0,726	0,730	0,600	0,872	
SS	0,751	0,746	0,620	0,674	0,808

Path Coefficients – Bootstrapping

Mean, STDEV, T-Values, P-Values

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
CP -> EP	0,442	0,442	0,091	4,839	0,000
CR -> EP	0,076	0,080	0,097	0,781	0,435
IT -> EP	0,124	0,126	0,088	1,411	0,158
SS -> EP	0,148	0,147	0,088	1,683	0,092

4th Model – Social Performance

R Square

	R Square	R Square Adjusted
SP	0,589	0,582

f Square

	CP	CR	IT	SP	SS
CP				0,069	
CR				0,056	
IT				0,007	
SP					
SS				0,022	

Construct Reliability and Validity

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
CP	0,921	0,923	0,938	0,717
CR	0,939	0,940	0,947	0,598
IT	0,841	0,855	0,904	0,759
SP	0,916	0,923	0,930	0,571
SS	0,924	0,927	0,937	0,653

Discriminant Validity

Fornell-Larcker Criterion

	CP	CR	IT	SP	SS
CP	0,847				
CR	0,800	0,773			
IT	0,728	0,731	0,871		
SP	0,723	0,715	0,628	0,755	
SS	0,752	0,746	0,675	0,664	0,808

Path Coefficients – Bootstrapping

Mean, STDEV, T-Values, P-Values

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
CP -> SP	0,316	0,313	0,079	3,994	0,000
CR -> SP	0,283	0,290	0,090	3,129	0,002
IT -> SP	0,083	0,081	0,077	1,083	0,279
SS -> SP	0,159	0,160	0,073	2,186	0,029

5th Model – Environmental Performance

R Square

	R Square	R Square Adjusted
EVP	0,511	0,503

f Square

	CP	CR	EVP	IT	SS
CP			0,076		
CR			0,021		
EVP					
IT			0,053		
SS			0,001		

Construct Reliability and Validity

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
CP	0,921	0,926	0,938	0,717
CR	0,939	0,940	0,947	0,598
EVP	0,851	0,869	0,889	0,575
IT	0,841	0,849	0,904	0,759
SS	0,924	0,924	0,938	0,653

Discriminant Validity

Fornell-Larcker

Criterion

	CP	CR	EVP	IT	SS
CP	0,847				
CR	0,799	0,773			
EVP	0,675	0,642	0,758		
IT	0,730	0,733	0,637	0,871	
SS	0,749	0,746	0,553	0,674	0,808

Path Coefficients – Bootstrapping

Mean, STDEV, T-Values, P-Values

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
CP -> EVP	0,360	0,354	0,099	3,640	0,000
CR -> EVP	0,188	0,195	0,096	1,964	0,050
IT -> EVP	0,256	0,244	0,087	2,943	0,003
SS -> EVP	-0,030	-0,013	0,099	0,298	0,765

Appendix 8 – 3rd Research Question on Smart-PLS 3.0

1st Model – Overall Developed Performance

R Square

	R Square	R Square Adjusted
SDP	0,693	0,682

f Square

	CP	CR	IT	ITI	Moderating Effect CP	Moderating Effect CR	Moderating Effect IT	Moderating Effect SS	SDP	SS
CP									0,039	
CR									0,020	
IT									0,008	
ITI									0,189	
Moderating Effect CP									0,025	
Moderating Effect CR									0,011	
Moderating Effect IT									0,000	
Moderating Effect SS									0,001	
SDP										
SS									0,026	

Construct Reliability and Validity

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
CP	0,921	0,923	0,938	0,717
CR	0,939	0,940	0,947	0,598
IT	0,841	0,851	0,904	0,759
ITI	0,841	0,849	0,894	0,680
Moderating Effect CP	1,000	1,000	1,000	1,000
Moderating Effect CR	1,000	1,000	1,000	1,000
Moderating Effect IT	1,000	1,000	1,000	1,000
Moderating Effect SS	1,000	1,000	1,000	1,000
SDP	0,960	0,963	0,963	0,506
SS	0,924	0,925	0,938	0,653

Discriminant Validity
Fornell-Larcker Criterion

	CP	CR	IT	ITI	Moderating Effect CP	Moderating Effect CR	Moderating Effect IT	Moderating Effect SS	OA	SS
CP	0,847									
CR	0,799	0,773								
IT	0,731	0,733	0,871							
ITI	0,550	0,560	0,508	0,790						
Moderating Effect CP	-0,417	-0,248	-0,275	-0,253	1,000					
Moderating Effect CR	-0,281	-0,284	-0,170	-0,173	0,832	1,000				
Moderating Effect IT	-0,305	-0,166	-0,291	-0,180	0,744	0,743	1,000			
Moderating Effect SS	-0,265	-0,161	-0,158	-0,114	0,694	0,697	0,650	1,000		
OA	0,614	0,580	0,560	0,606	-0,324	-0,204	-0,252	-0,184	0,848	
SS	0,749	0,743	0,671	0,404	-0,249	-0,171	-0,165	-0,311	0,519	0,808

Outer Loadings

	CP	CR	IT	ITI	SDP	SS
CP1	0,806					
CP2	0,869					
CP3	0,887					
CP4	0,850					
CP5	0,823					
CP6	0,845					
CR1		0,808				
CR10		0,746				
CR11		0,682				
CR12		0,729				
CR2		0,765				
CR3		0,834				
CR4		0,781				
CR5		0,805				
CR6		0,741				
CR7		0,796				
CR8		0,810				
CR9		0,771				

EP2					0,742	
EP3					0,696	
EP4					0,767	
EP7					0,753	
EP8					0,726	
EP9					0,712	
EVP1					0,722	
EVP2					0,670	
EVP3					0,724	
EVP4					0,415	
EVP5					0,777	
EVP6					0,788	
IT1			0,834			
IT2			0,918			
IT3			0,860			
ITI1				0,735		
ITI10				0,851		
ITI11				0,793		
ITI12				0,689		
ITI2				0,303		
ITI3				0,661		
ITI4				0,370		
ITI5				0,758		
ITI6				0,652		
ITI7				0,409		
ITI8				0,438		
ITI9				0,656		
OA1					0,737	
OA2					0,757	
OA3					0,741	
OA4					0,675	
SP1					0,771	
SP10					0,746	
SP2					0,776	
SP3					0,713	
SP4					0,595	
SP5					0,557	
SP6					0,655	
SP7					0,565	

SP8					0,829	
SP9					0,746	
SS2						0,857
SS3						0,860
SS4						0,809
SS5						0,780
SS6						0,764
SS7						0,816
SS8						0,753
SS1						0,819

2nd Model – Overall Awareness Developed Performance

R Square

	R Square	R Square Adjusted
OA	0,511	0,493

f Square

	CP	CR	IT	ITI	Moderating Effect CP	Moderating Effect CR	Moderating Effect IT	Moderating Effect SS	OA	SS
CP									0,006	
CR									0,010	
IT									0,003	
ITI									0,151	
Moderating Effect CP									0,019	
Moderating Effect CR									0,013	
Moderating Effect IT									0,006	
Moderating Effect SS									0,001	
OA										
SS									0,007	

Construct Reliability and Validity

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
CP	0,921	0,926	0,938	0,717
CR	0,939	0,940	0,947	0,598
IT	0,841	0,856	0,904	0,758
ITI	0,848	0,850	0,892	0,624
Moderating Effect CP	1,000	1,000	1,000	1,000

Moderating Effect CR	1,000	1,000	1,000	1,000
Moderating Effect IT	1,000	1,000	1,000	1,000
Moderating Effect SS	1,000	1,000	1,000	1,000
OA	0,868	0,869	0,911	0,719
SS	0,924	0,927	0,938	0,653

Discriminant Validity
Fornell-Larcker Criterion

	CP	CR	IT	ITI	Moderating Effect CP	Moderating Effect CR	Moderating Effect IT	Moderating Effect SS	OA	SS
CP	0,847									
CR	0,799	0,773								
IT	0,731	0,733	0,871							
ITI	0,550	0,560	0,508	0,790						
Moderating Effect CP	-0,417	-0,248	-0,275	-0,253	1,000					
Moderating Effect CR	-0,281	-0,284	-0,170	-0,173	0,832	1,000				
Moderating Effect IT	-0,305	-0,166	-0,291	-0,180	0,744	0,743	1,000			
Moderating Effect SS	-0,265	-0,161	-0,158	-0,114	0,694	0,697	0,650	1,000		
OA	0,614	0,580	0,560	0,606	-0,324	-0,204	-0,252	-0,184	0,848	
SS	0,749	0,743	0,671	0,404	-0,249	-0,171	-0,165	-0,311	0,519	0,808

3rd Model – Economy Performance:

R Square

	R Square	R Square Adjusted
EP	0,606	0,591

f Square

	CP	CR	EP	IT	ITI	Moderating Effect CP	Moderating Effect CR	Moderating Effect IT	Moderating Effect SS	SS
CP			0,040							
CR			0,002							
EP										
IT			0,002							
ITI			0,168							
Moderating Effect CP			0,023							

Moderating Effect CR			0,014							
Moderating Effect IT			0,000							
Moderating Effect SS			0,000							
SS			0,028							

Construct Reliability and Validity

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
CP	0,921	0,922	0,938	0,718
CR	0,939	0,940	0,947	0,598
EP	0,896	0,910	0,916	0,555
IT	0,841	0,845	0,905	0,760
ITI	0,848	0,859	0,892	0,625
Moderating Effect CP	1,000	1,000	1,000	1,000
Moderating Effect CR	1,000	1,000	1,000	1,000
Moderating Effect IT	1,000	1,000	1,000	1,000
Moderating Effect SS	1,000	1,000	1,000	1,000
SS	0,924	0,924	0,938	0,653

Discriminant Validity

Fornell-Larcker Criterion

	CP	CR	EP	IT	ITI	Moderating Effect CP	Moderating Effect CR	Moderating Effect IT	Moderating Effect SS	SS
CP	0,847									
CR	0,798	0,773								
EP	0,703	0,629	0,745							
IT	0,726	0,730	0,599	0,872						
ITI	0,546	0,560	0,621	0,501	0,790					
Moderating Effect CP	-0,411	-0,239	-0,316	-0,265	-0,237	1,000				
Moderating Effect CR	-0,271	-0,278	-0,170	-0,160	-0,165	0,825	1,000			
Moderating Effect IT	-0,293	-0,157	-0,197	-0,274	-0,162	0,731	0,738	1,000		
Moderating Effect SS	-0,265	-0,158	-0,198	-0,160	-0,110	0,695	0,699	0,658	1,000	
SS	0,751	0,746	0,619	0,674	0,406	-0,249	-0,168	-0,166	-0,309	0,808

4th Model: Social Performance:

R Square

	R Square	R Square Adjusted
SP	0,628	0,615

f Square

	CP	CR	IT	ITI	Moderating Effect CP	Moderating Effect CR	Moderating Effect IT	Moderating Effect SS	SP	SS
CP									0,031	
CR									0,022	
IT									0,003	
ITI									0,099	
Moderating Effect CP									0,003	
Moderating Effect CR									0,000	
Moderating Effect IT									0,002	
Moderating Effect SS									0,000	
SP										
SS									0,032	

Construct Reliability and Validity

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
CP	0,921	0,923	0,938	0,717
CR	0,939	0,940	0,947	0,598
IT	0,841	0,855	0,904	0,759
ITI	0,841	0,850	0,894	0,680
Moderating Effect CP	1,000	1,000	1,000	1,000
Moderating Effect CR	1,000	1,000	1,000	1,000
Moderating Effect IT	1,000	1,000	1,000	1,000
Moderating Effect SS	1,000	1,000	1,000	1,000
SP	0,916	0,924	0,930	0,570
SS	0,924	0,927	0,937	0,653

Discriminant Validity
Fornell-Larcker Criterion

	CP	CR	IT	ITI	Moderating Effect CP	Moderating Effect CR	Moderating Effect IT	Moderating Effect SS	SP	SS
CP	0,847									
CR	0,800	0,773								
IT	0,728	0,731	0,871							
ITI	0,544	0,563	0,499	0,824						
Moderating Effect CP	-0,389	-0,226	-0,249	-0,223	1,000					
Moderating Effect CR	-0,254	-0,263	-0,148	-0,165	0,817	1,000				
Moderating Effect IT	-0,273	-0,144	-0,254	-0,140	0,733	0,745	1,000			
Moderating Effect SS	-0,252	-0,154	-0,148	-0,135	0,704	0,719	0,665	1,000		
SP	0,722	0,716	0,628	0,594	-0,276	-0,202	-0,167	-0,197	0,755	
SS	0,752	0,746	0,675	0,401	-0,244	-0,167	-0,157	-0,296	0,663	0,808

5th Model: Environmental Performance:

R Square

	R Square	R Square Adjusted
EVP	0,576	0,560

f Square

	CP	CR	EVP	IT	ITI	Moderating Effect CP	Moderating Effect CR	Moderating Effect IT	Moderating Effect SS	SS
CP			0,016							
CR			0,020							
EVP										
IT			0,015							
ITI			0,105							
Moderating Effect CP			0,020							
Moderating Effect CR			0,019							
Moderating Effect IT			0,022							
Moderating Effect SS			0,008							
SS			0,002							

Construct Reliability and Validity

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
CP	0,921	0,926	0,938	0,717
CR	0,939	0,940	0,947	0,598
EVP	0,851	0,866	0,889	0,575
IT	0,841	0,849	0,904	0,759
ITI	0,841	0,852	0,894	0,679
Moderating Effect CP	1,000	1,000	1,000	1,000
Moderating Effect CR	1,000	1,000	1,000	1,000
Moderating Effect IT	1,000	1,000	1,000	1,000
Moderating Effect SS	1,000	1,000	1,000	1,000
SS	0,924	0,924	0,938	0,653

Discriminant Validity Fornell-Larcker Criterion

	CP	CR	EVP	IT	ITI	Moderating Effect CP	Moderating Effect CR	Moderating Effect IT	Moderating Effect SS	SS
CP	0,847									
CR	0,799	0,773								
EVP	0,674	0,640	0,758							
IT	0,730	0,733	0,636	0,871						
ITI	0,549	0,565	0,592	0,504	0,824					
Moderating Effect CP	-0,393	-0,230	-0,308	-0,255	-0,231	1,000				
Moderating Effect CR	-0,260	-0,266	-0,187	-0,156	-0,169	0,820	1,000			
Moderating Effect IT	-0,280	-0,151	-0,257	-0,261	-0,145	0,737	0,749	1,000		
Moderating Effect SS	-0,253	-0,156	-0,154	-0,148	-0,138	0,706	0,723	0,664	1,000	
SS	0,749	0,746	0,552	0,674	0,402	-0,245	-0,171	-0,158	-0,296	0,808