THE INFLUENCE OF DIGITAL ORIENTATION ON FINANCIAL PERFORMANCE IN MALAYSIAN MANUFACTURING FIRMS: THE MEDIATING ROLES OF SUPPLY CHAIN INTEGRATION, EXPLORATORY INNOVATION AND EXPLOITATIVE INNOVATION

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LIST OF ABBREVIATIONS

4IR	Fourth Industrial Revolution
ANN	Artificial Neural Networking
ASEAN	Association of Southeast Asian Nations
AVE	Average Variance Extracted
CB-SEM	Covariance-based Structural Equation Modeling
CMV	Common Method Variance
CR	Composite Reliability
CPS	Cyber-Physical System
CPTPP	Comprehensive and Progressive Agreement for Trans-Pacific Partnership
DO	Digital Orientation
DOSM	Department of Statistics Malaysia
E&E	Electrical & Electronic
EI	Exploitative Innovation
EU	European Union
EY	Exploratory Innovation
f^2	Effect Size
FMM	Federal of Malaysian Manufacturers
FDI	Foreign Direct Investment
FTA	Free Trade Agreements
FP	Financial Performance
GDP	Gross Domestic Product
HTMT	Heterotrait-Monotrait Ratio of Correlations
IDTF	Industry Digitalisation Transformation Fund
ICT	Information Communications Technology
IoT	Internet of Things
M&E	Machinery and Equipment
MAE	Mean Absolute Error
MATRADE	Malaysia External Trade Development Corporation
MIDA	Malaysian Industrial Development Authority
MITI	Ministry of Investment, Trade and Industry
MSME	Micro, Small, and Medium Enterprise

MTCs	Mid-Tier Companies
NRBV	Natural Resource Based View
NPD	New Product Development
PLS-SEM	Partial Least Square Structural Equation Modeling
PMI	Purchasing Managers Index
PwC	PricewaterhouseCoopers
Q^2	Predictive Relevance
R&D	Research and Development
R&D&C	Research, Development and Commercialisation
R^2	Coefficient of Determination
RBV	Resource-Based View
RFID	Radio-Frequency Identification
RMSE	Root Mean Square Error
ROA	Return on Assets
ROI	Return on Investment
ROS	Return on Sales
SaaS	Software-as-a-Service
S&P	Standard and Poor
SAG	Smart Automation Grant
SCI	Supply Chain Integration
SEM	Structural Equation Model
SME	Small and Medium Enterprise
UNCTAD	United Nations Conference on Trade and Development

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PENGARUH ORIENTASI DIGITAL TERHADAP PRESTASI KEWANGAN DI FIRMA PEMBUATAN: PERANAN PENGANTARA INTEGRASI RANTAI BEKALAN, INOVASI EKSPLORATORI DAN INOVASI EKSPLOITATIF

ABSTRAK

Orientasi digital (DO) telah muncul sebagai strategi penting bagi firma pembuatan untuk meningkatkan operasi mereka, memupuk inovasi, dan mencapai kelebihan daya saing. Orientasi digital telah muncul sebagai strategi penting bagi firma pembuatan untuk meningkatkan operasi, menggalakkan inovasi, dan mencapai kelebihan daya saing. Dengan mengintegrasikan orientasi digital, firma dapat mengoptimumkan proses rantaian bekalan dan meningkatkan prestasi keseluruhan. Walau bagaimanapun, cabaran seperti kesan bullwhip dan kelewatan dalam inovasi masih berterusan, yang mengehadkan potensi penuh orientasi digital. Oleh itu, pemahaman yang komprehensif mengenai bagaimana orientasi digital berinteraksi dengan integrasi rantaian bekalan, inovasi eksploratori, dan inovasi eksploitatif adalah diperlukan untuk mendorong prestasi kewangan. Berlandaskan kepada Teori Sumber Berasaskan dan Teori Pemegang Taruh, kajian ini meneliti hubungan antara orientasi digital, integrasi rantaian bekalan, inovasi eksploratori, inovasi eksploitatif, dan prestasi kewangan. Kajian kuantitatif telah dijalankan dalam kalangan firma pembuatan yang disenaraikan dalam *Direktori Persekutuan Pengilang Malaysia (Edisi ke-53). Soal selidik menghasilkan 165 respons yang boleh digunakan. Analisis deskriptif dijalankan untuk menilai ciri demografi, manakala Partial Least Squares Structural Equation Modeling digunakan untuk menguji hubungan yang dihipotesiskan.* Penemuan kajian menunjukkan bahawa orientasi digital memberi

kesan positif terhadap integrasi rantaian bekalan dan prestasi kewangan, manakala inovasi eksploitatif memainkan peranan penting dalam menterjemahkan strategi digital kepada kejayaan kewangan. Kajian ini meneliti tiga pemboleh ubah perantara, iaitu integrasi rantaian bekalan, inovasi eksploratori, dan inovasi eksploitatif. Hasil analisis menunjukkan bahawa hanya inovasi eksploitatif yang mempunyai kesan perantaraan yang signifikan antara orientasi digital dan prestasi kewangan. Ini mencadangkan bahawa firma yang memanfaatkan pengetahuan sedia ada dan menambah baik proses melalui inovasi eksploitatif memperoleh manfaat kewangan yang lebih besar berbanding firma yang hanya menumpukan pada integrasi atau inovasi eksploratori. Bagi meningkatkan ketepatan ramalan, Rangkaian Neural Buatan telah digabungkan dengan pemodelan persamaan struktur kaedah kuasa dua terkecil separa, yang mendedahkan interaksi kompleks dan tidak linear antara orientasi digital, integrasi rantaian bekalan, inovasi, dan prestasi. Penemuan ini memberikan bukti empirikal tentang kepentingan strategik orientasi digital dan integrasi rantaian bekalan dalam mendorong prestasi kewangan yang unggul. Hasil kajian ini menawarkan implikasi praktikal bagi pengurus dan pembuat dasar dalam usaha mengoptimumkan strategi digital, memperkukuh integrasi rantaian bekalan, serta menggalakkan inovasi bagi memperoleh kelebihan daya saing dalam sektor pembuatan.

THE INFLUENCE OF DIGITAL ORIENTATION ON FINANCIAL PERFORMANCE IN MALAYSIAN MANUFACTURING FIRMS: THE MEDIATING ROLES OF SUPPLY CHAIN INTEGRATION, EXPLORATORY INNOVATION AND EXPLOITATIVE INNOVATION

ABSTRACT

Digital orientation has emerged as a crucial strategy for manufacturing firms to enhance operations, foster innovation, and achieve a competitive advantage. By integrating digital orientation, firms can optimize supply chain processes and improve overall performance. However, challenges such as the bullwhip effect and delays in innovation and redesign issues persist, limiting the full potential of digital orientation. These challenges necessitate a comprehensive understanding of how digital orientation interacts with supply chain integration, exploratory innovation, and exploitative innovation to drive financial performance. Drawing on the Resource-Based View and Stakeholder Theory, the current study investigates the linkages between digital orientation, supply chain integration, exploratory innovation, exploitative innovation, and financial performance. A quantitative survey was conducted with the manufacturing firms covered under the Federation of Malaysian Manufacturers Directory of Malaysian Industries (53rd Edition), yielding 165 usable responses. Demographic characteristics were assessed through descriptive analysis, and Partial Least Squares Structural Equation Modelling (PLS-SEM) was employed to test the hypothesised relationships. The results suggest that a strong digital orientation significantly enhances supply chain integration and financial outcomes. The study

examines three mediating variables: supply chain integration, exploratory innovation. Additionally, exploitative innovation serves as a key mechanism in converting digital strategies into tangible financial gains. In this study, the results reveal that the only mediating effect between digital orientation and financial performance is with exploitative innovation. This suggests that firms leveraging existing knowledge and refining processes through exploitative innovation gain more substantial financial benefits than those focusing solely on integration or exploratory efforts. To improve predictive accuracy, Artificial Neural Networks (ANN) were combined with PLS-SEM. The application of both ANN and PLS-SEM uncovers complex and non-linear relationships between digital orientation, supply chain integration, innovations and performance. The findings offer empirical support for the strategic importance of digital orientation and supply chain integration in achieving enhanced financial outcomes. The results have implications for practice and policymakers. The findings are targeted to maximize digital strategies, enhance supply chain alignment, and drive innovation with the goal of obtaining a competitive advantage in the manufacturing industry.

CHAPTER 1

INTRODUCTION

1.1 Introduction

Throughout history, Malaysia has been strongly linked with international trade. Malaysia holds a position amongst the top 25 global trading nations and is ranked within the top five ASEAN nations. However, as other developing countries increasingly demonstrate competitiveness, and Malaysia's reputation as a low-cost manufacturing centre faded, its ranking in global trade has declined from its standing two decades ago. Nevertheless, the trade performance of Malaysia in 2024 reached a record high, with total trade expanding by 9.2% year-on-year to RM2.88 trillion. Export values increased by 5.7% to RM1.508 trillion, marking the second consecutive year of surpassing the RM1.5 trillion threshold. Imports rose by 13.2% to RM1.371 trillion, resulting in a trade surplus of RM136.88 billion, the highest in the nation's history. (MATRADE, 2025).

Since the early 1970s, Malaysia has welcomed significant foreign direct investments, particularly in the Electrical & Electronic (E&E) sector, which has facilitated the transfer of knowledge and technology, leading to the cultivation of capabilities within the local Micro, Small, and Medium Enterprises (MSMEs). This development has further augmented the burgeoning entrepreneurial culture among Malaysians, serving as an enabler for Malaysia's recognition as an economic tiger within the ASEAN region, as it stands as one of the founding members of the regional grouping (MATRADE, 2022).

The economic development can be substantiated by the sales value of the manufacturing sector, which recorded a total value of RM148.00 billion in January 2023, with 71.3% of the contribution coming from export-oriented industries, and

28.7% from domestic-oriented industries. The electrical and electronics (E&E) products (30.4%), petroleum, chemical, rubber, and plastics (28.0%), food, beverages, and tobacco (16.8%), and other subsectors made up more than two-thirds of the manufacturing sales value. Besides, the industry also makes a major contribution towards job creation as evidenced by the 2.34 million persons employed. This recorded a 3% increase from the 2.27 million persons employed in 2022 (DOSM, 2023).

Malaysia's manufacturing industry is still a major force behind the nation's economic development. The manufacturing sector helps maintain growth in the face of global uncertainty by making a substantial contribution to export earnings and job creation. The emphasis going forward would be on creating more complicated, varied, and high-value products. The catalytic sub-sectors—in particular, E&E, machinery and equipment (M&E), and chemicals and chemical products—are important areas for development. Additionally, Malaysia plans to explore the highly promising subsectors of medical devices and aircraft (MIDA, 2023)

Malaysia is moving into complex and high-value industries. The competitiveness of a nation cannot depend solely on trade volumes. Firms must also integrate supply chains and adopt digital strategies. Performance, particularly in the manufacturing industry could be enhanced to continuously support the international trade of Malaysia The manufacturing industry involves various stakeholders with different interests. Therefore, assessing the supply chain integration's impact is crucial. Exploratory and exploitative innovation also influence overall performance. Understanding these factors helps improve industry effectiveness. Additionally, this thesis incorporates digital orientation to assess its influence on supply chain integration and innovation, to enhance performance. Furthermore, digital orientation is included in

this thesis to determine its role on supply chain integration and innovations for performance enhancement.

The subsequent sections, including Section 1.2 to Section 1.8 describe the background of the study, the focal industry, problem statement, research objectives and questions, and definitions of key terms. Lastly, the chapter summary is presented in section 1.9.

1.2 Background of Study

S&P Global Malaysia Manufacturing Purchasing Managers' Index (PMI) dropped according to S&P Global data. The world electronics manufacturing industry is currently struggling with the accelerating global economic growth. As shown in Figure 1.1, the S&P Global Electronics PMI posted a drop from 50.1 in December 2022 to 48.9 in January 2023 signifying a deterioration in the operational landscape for the global electronics manufacturing sector in 2023. The data has also demonstrated a resurgence of contraction within the global electronics sector, as evidenced by the continued decrease in new orders and output. This signifies a restraint of growth momentum for Malaysia's E&E industry, compared to the notably rapid expansion experienced in 2022 (Biswas, 2023).

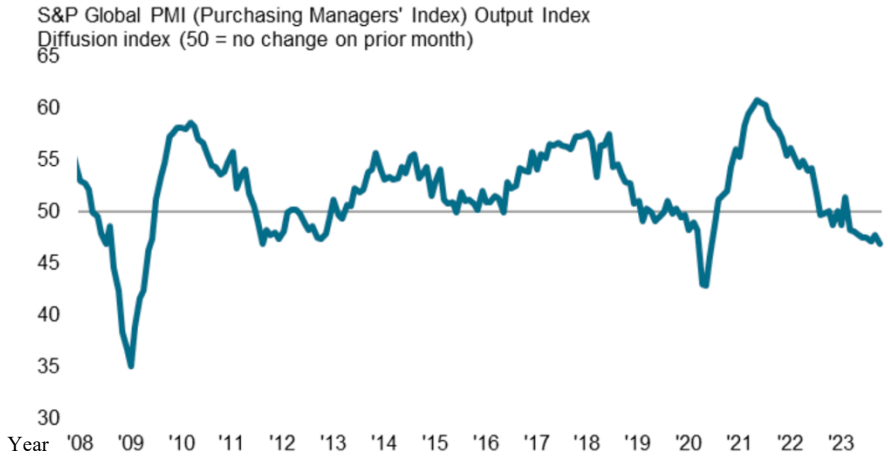

Figure 1.1 S&P Global Electronic PMI

The challenging conditions precipitated the limited demand and production for Malaysian manufacturing firms. Despite this, early PMI data for 2023 still suggested that there was still growth in official data for the start of the year, although at a moderate pace (S&P Global, 2023). As shown in Figure 1.2, Malaysia Manufacturing PMI has remained largely volatile since 2013, reflecting persistent pressure on the industry. The latest survey outcomes revealed two favourable developments (S&P Global, 2023). Firstly, employment experienced renewed expansion, which enabled firms to manage their workload and established a foundation for future output expansion if demand were to recover. Secondly, delivery times observed their first reduction in over three years, as normalization occurred in material shortages, port congestion, and delivery issues. The improved availability of materials also contributed to the current sequence of inflation's slowest rise in input prices, which commenced in June 2020 (S&P Global, 2023).

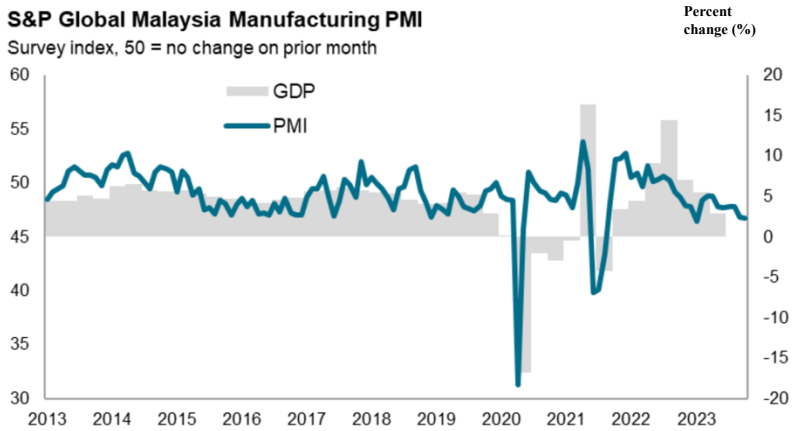

Figure 1.2 Malaysia Manufacturing PMI

The seasonally adjusted S&P Global PMI experienced a decline from 47.8 in December 2023 to 46.5 in January 2024, indicating a softening momentum in the manufacturing sector (Biswas, 2023; The Star, 2023). This latest reading at 49.7 in July 2024 signals a modest contraction and suggests that the Malaysian manufacturing sector

experienced a muted demand, reductions in new orders, production, employment, and stocks. Despite some growth in export orders, overall domestic demand remained weak. Rising input costs, including raw materials and transportation, pushed input cost inflation to an eight-month high, resulting in the steepest increase in output prices since September 2022 (S&P Global, 2024; Trading Economics, 2024). This combination of weaker demand, reduced production, and rising costs suggests a potential for weaker financial performance in the sector, with optimism for recovery tempered by concerns over domestic demand.

In addition to the optimistic projections of the PMI, there exist continued endeavours to attract high-quality investments and elevate Malaysian firms. This particularly happened in the SMEs, towards a superior position within the global value chain. Malaysia managed to draw RM170 billion of potential foreign direct investment (FDI) and RM2.44 billion of potential exports in 2023. The results demonstrate strong confidence in Malaysia's key target sectors, including E&E and the digital economy. Moreover, the FDI influx will generate higher-paying employment opportunities for Malaysians (MITI, 2023).

Global manufacturing has been hampered by the bullwhip effect. This is witnessed in the semiconductor and automotive industries arose due to fluctuating demand during the pandemic. Early demand declines led manufacturers to reduce orders, but a surge in electronics consumption later created a chip shortage. This mismatch caused production delays, increased lead times, and price hikes in sectors such as automotive and consumer electronics, affecting even companies like Toyota with strong supply chain systems (Channel News Asia, 2021). Ge-Shen Corp Bhd, the plastic injection moulding manufacturer in Malaysia has long suffered from the bullwhip effect as well (The Edge Malaysia, 2023). The bullwhip effect for Ge-Shen

Corp Bhd is anticipated due to fluctuating demand across industries. After an inventory build-up during the pandemic, companies may soon experience a sudden increase in demand as inventories drop, especially in Western markets. This could impact supply chains, leading to supply-demand mismatches. Ge-Shen's strategic moves to diversify into sectors like medical manufacturing and expand its facilities aim to mitigate these challenges and sustain growth (The Edge Malaysia, 2023).

Heizer et al (2023) have demonstrated the effects of the bullwhip phenomenon, emphasizing the consequences beyond production schedule disruptions. As illustrated in Figure 1.3, a small increase in customer demand can trigger amplified responses along the supply chain. These outcomes extend to critical operational factors such as overtime, subcontracting, asset expansion, workforce adjustments and layoffs. These would ultimately increase the risk of raw material stock expiration.

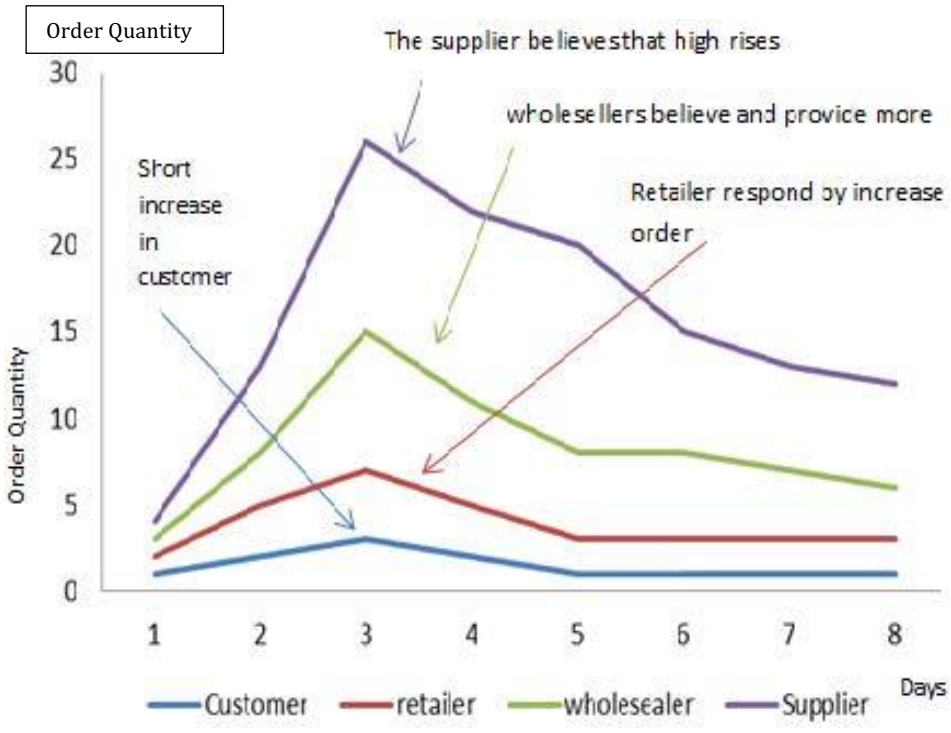

Figure 1.3 The illustrated impact of the Bullwhip Effect

Apart from the longstanding issues of bullwhip effect, Malaysia made a significant leap by signing the Comprehensive and Progressive Agreement for Trans-

Pacific Partnership (CPTPP). The CPTPP is regarded as the most ambitious trade agreement signed, removing 98% of tariffs within a trade bloc with a combined Gross Domestic Product (GDP) value amounting to USD13.5 trillion or 13.4% of the world's GDP and a population exceeding 500 million. The United Kingdom's prospective membership into in the CPTPP will open new opportunities for Malaysian businesses and SMEs. It will include wider channels for the procurement of materials at favourable prices as well as technical assistance and capacity improvement schemes, further driving the economic performance of Malaysia and the strengthening of the supply chains within the region (MITI, 2023). The positive outcomes arising from the foreign direct investment (FDI) and free trade agreement (FTA) serve as evidence that the integration and collective collaboration have relevance in enhancing the supply chain.

FDI inflows and CPTPP create incentives for firms to adopt digital technologies. External investment provides capital and transfers knowledge. This flow of resources accelerates digital adoption. Supply chain integration gains strength through new expertise. Innovation receives support from exposure to advanced practices. Together, external drivers connect directly with digital orientation and financial performance.

When it comes to the development of Malaysia's manufacturing industry Recognition is given for the contribution made by the Mid-Tier Companies (MTCs), which account for 30% of the GDP and 22% of the Malaysian workforce. Although MTCs make up only 1% of Malaysian enterprises, the MTCs are the ones who create a domestic supply chain with a level playing ground for competition with 7,000 SMEs (75%) involved in the export supply chain of the MTCs (MATRADE, 2023).

The importance of digital and innovation has been highlighted as the factors that will enhance the resilience of MTCs in readiness under the Industry4WRD initiative for imminent challenges. MTCs are encouraged to venture into new niche markets and

broaden the base of the market, increase productivity and implement viable strategies and plans for the implementation of outcome-based intervention projects. Implementing these key factors will make MTCs more dynamic, agile, and competitive (MIDA, 2023). These initiatives reflect the dedication of the government to embracing the Fourth Industrial Revolution (4IR). These projects also to maintain the competitiveness of the manufacturing sector. The focus is on the areas of talent, innovation, productivity and the establishment of the jobs necessary for economic growth (MIDA, 2023).

To accelerate automation in 2021, the government allocated funds. RM100 million was provided for the Smart Automation Grant (SAG) under the PENJANA package. Additionally, RM50 million was included in the PEMERKASA aid package. The SAG is intended to promote the adoption of automation and digitalization by the middle-tier businesses and the small and medium-sized enterprises (SMEs). The government agency also supports and helps the businesses towards speeding up the digital technologies and serves as a catalyst for the digital economy (MIDA, 2023).

The manufacturing industry is still centered around talent cultivation and industry 4.0 in Malaysia. The emphasis lies in the revitalization of current sectors and the unlocking of new ones. To increase productivity, firms are encouraged to push innovation, automation, carry out research, development, and commercialization (R&D&C), implement sustainable and environmentally sound production approaches and leverage industry collaboration to share the best practices (MIDA, 2023).

Malaysia's effort in putting the nation's manufacturing in a better position internationally should not slacken. It is equally important for Malaysia to develop competency within the manufacturing industry in moving forward to meet current and future challenges. To this end, the key factors that enable innovation through digital and

collaborations with partners of this research are expected to uncover the factors for the way forward.

1.3 Problem Statement

The global manufacturing industry still suffers from (1) the bullwhip effect (Giri & Glock, 2022, Meier, 2022), (2) delay of innovation (Flagg, 2023) and (3) redesigning product without new features (Flagg, 2023) even with ongoing efforts on digital orientation (Skritek-Deim et al., 2023, UNCTAD, 2023). Similarly, despite the efforts of digital orientation (Skritek-Deim et al., 2023, UNCTAD, 2023), the manufacturing industry has undergone decelerating growth and declining profits in the unprecedented economic uncertainty (Marr, 2023). Nevertheless, achieving strong financial performance remains a focal point that often encounters challenges from various factors (Nhung et al., 2021). Despite the parallel digital orientation (UNCTAD, 2023), the manufacturing industry has experienced challenges from the bullwhip effect and delayed innovation.

Sections 1.3.1 to 1.3.5 present these challenges in detail. The discussion also introduces the need for advanced analytical approaches such as ANN to capture non-linear relationships.

1.3.1 Bullwhip Effect (RO1, RO4 & RO8) (H1, H4, H8)

Manufacturers have long struggled with the bullwhip effect, where changes in orders are bigger than changes in sales, leading to higher production costs (Lee et al. 1997). The literature examined two major issues: demand variability and intra-firm bullwhip. The reviewed literature identifies two primary concerns: demand variability and intra-firm bullwhip. The demand variability refers to fluctuations in the total customer demand encountered by manufacturers (Cachon et al. 2007; Bray &

Mendelson, 2012). This phenomenon is also known as "felt" bullwhip effect from the the end customer (Osadchiy et al., 2021). Meanwhile, intra-firm bullwhip is the variations in a production levels of a firm that arises in response to shifts in demand (Lee et al. 1997; Chen et al. 2000; Croson & Donohue, 2006). Both the issues create unnecessary inventory and production costs have attracted the attention of industry as well as academicians (Niu et al., 2024). The bullwhip effect can be expensive for all the supply chain members. Overstock can cause wastage, and understock can cause stockouts and missed sales opportunities (Sarkar et al., 2023). The impacts highlights the importance of supply chain integration in mitigating inefficiencies that directly influence financial performance.

The supply chain ecosystem manufacturing is challenged by the bullwhip effect that exacerbates process inefficiencies, communication breakdowns, workforce capacity and profitability (Meier, 2022). The bullwhip effect is caused by distorted and scattered information within the supply chain that could lead to extensive and costly inventory investment, potential loss of revenues, and misplanned of the capacity (Dai et al., 2016; Lee et al, 1997). The bullwhip effect impacts highlight the importance of supply chain integration in mitigating inefficiencies. The resulting challenges influence financial performance in a systematically and persistently, not merely as seasonal fluctuations.

1.3.2 Delayed Innovation (RO2, RO5 & RO9) (H2, H5 & H9)

The delay of innovation has caused lost revenue and opportunities to tap into new markets for increasing market share (Flagg, 2023). Manufacturers are constantly surprised and have to fix or delay product innovation that could devote up to 60% of engineering capacity (Flagg, 2023). It is common in the automotive industry, where

firms delay the introduction of some new features (Flagg, 2023). A rearview camera might be delivered without augmented reality, USB ports could be absent, or hands-free driving might be restricted (Walsh, 2022).

Without exploratory innovation, a firm faces difficulties in renewing and updating business processes by using technological solutions (Dixit et al., 2022). This constraint limits profitability and overall financial performance (Huang, 2023).

1.3.3 Redesigning Product without New Features (RO3, RO6 & RO10) (H3, H6 & H10)

Firms and their engineering teams redesign products already in the market without adding new functionality. This is to compensate for missing components (Flagg, 2023). Without exploitative innovation to synchronize the utilization of existing technological goals to maximize gains (Dixit et al., 2022) the manufacturer would fail to reap the market share with the new product release. Ultimately, financial performance would be constrained.

Tesla faced a shortage of ultrasonic sensors and removed them from its vehicles in a move that impacted features such as parking assist and proximity detection. This was part of Tesla's shift towards a "Tesla Vision" system, relying solely on cameras instead of sensors. While this temporarily limited some features, Tesla promised to restore and even improve functionality through future software updates. This decision was driven partly by component shortages and partly by Tesla's goal to innovate using fewer hardware components (Templeton, 2022; Tesla, 2024).

1.3.4 Challenges in Linking Digital Orientation to Financial Performance (RO7) (H7)

Digital orientation, defined as an organization's strategic inclination toward the adoption and integration of digital technologies to enhance its operational structures and processes, has become increasingly significant in today's competitive landscape (Barba-Sánchez et al., 2024). However, many firms continue to encounter substantial challenges in embracing technological innovations, often resulting in operational inefficiencies and disruptions to business continuity and financial performance (Dam et al., 2025). Although prior studies have indicated a generally positive association between digital orientation and organizational performance, the nature of this relationship remains insufficiently explored and understood (Jang & Lee, 2025).

1.3.5 To assess the non-linear relationships between factors (RO11) (H11)

This study seeks to bridge the existing gap. Specifically, the research examines the structural model results related to identifying how key constructs influence the firms' financial outcomes. A literature review reveals that most studies utilize linear statistical techniques such as SEM to identify factors influencing firms' sustainable performance (Chatterjee et al., 2022; Singh et al., 2022). However, SEM cannot assess the non-linear relationships between factors, which simplifies complex and critical decision-making processes (Al-Sharafi et al., 2022). Previous scholars have advocated for the conjoining of Artificial Neural Networks (ANN) with the SEM approach for the determination of the linear and non-linear relationship and relative salient construct ranking to address this issue (Asadi et al., 2021; Lee et al., 2020; Yadegaridehkordi et al., 2023). ANN enhances SEM by identifying both linear and non-linear relationships among the constructs (Sharma et al., 2021) to better capture the financial performance in this study.

1.4 Research Objectives

As the manufacturing industry experienced a bullwhip effect, delayed innovation, and redesign to cope with missing components. This is crucial to identify the relevant influencing factors. The research objective of this study is to examine the relationships among the key factors, including digital orientation, supply chain integration, exploratory innovation, and exploitative innovation, to improve the financial performance of the manufacturing industry. The aim of understanding the linkages and relationships among the key factors is to mitigate the bullwhip effect and improve the introduction of innovation by investigating the role of mediating factors, including supply chain integration, exploratory innovation, and exploitative innovation in impacting financial performance in the manufacturing industry. The research objectives of the study are outlined as bellows to identify the critical factors from the manufacturing industry performance that could be improved:

a) To examine the relationship between digital orientation and supply chain integration
b) To examine the relationship between digital orientation and exploratory innovation.
c) To examine the relationship between digital orientation and exploitative innovation.
d) To examine the relationship between supply chain integration and financial performance.
e) To examine the relationship between exploratory innovation and financial performance.
f) To examine the relationship between exploitative innovation and financial performance.
g) To examine the relationship between digital orientation and financial performance.
h) To examine the mediating role of supply chain integration on the relationship between digital orientation and financial performance.

i) To examine the mediating role of exploratory innovation on the relationship between digital orientation and financial performance.

j) To examine the mediating role of exploitative innovation on the relationship between digital orientation and financial performance.

k) To validate the structural model result of financial performance analysis using ANN.

1.5 Research Question

To explore the phenomenon of bullwhip effects and delayed innovation in the manufacturing industry, the following are the research questions:

a) Does digital orientation influence supply chain integration?

b) Does digital orientation influence exploratory innovation?

c) Does digital orientation influence exploitative innovation?

d) Does supply chain integration influence financial performance?

e) Does exploratory innovation influence financial performance?

f) Does exploitative innovation influence financial performance?

g) Does digital orientation influence financial performance?

h) Does supply chain integration mediate the relationship between digital orientation and financial performance?

i) Does exploratory innovation mediate the relationship between digital orientation and financial performance?

j) Does exploitative innovation mediate the relationship between digital orientation and financial performance?

k) Does ANN validate the structural model result of financial performance analysis?

1.6 Significance of the Study

This study bridges the literature gap by investigating the causal relationships among digital orientation, supply chain integration, exploratory innovation, exploitative innovation, and financial performance. Previous research has not examined these relationships within a single framework. The study also expands theoretical frameworks by incorporating the mediating roles of supply chain integration, exploratory innovation, and exploitative innovation. These mediators explain the pathway through which digital orientation enhances financial performance. The structural model extends earlier works by emphasizing supply chain integration, exploratory innovation, and exploitative innovation as critical links for leveraging digital operations to improve performance. Methodological significance is introduced through the use of an ANN to validate the structural model. ANN enhances the robustness of the findings.

The empirical results of the study offer practical implications for businesses managing global supply chain challenges, especially concerning digital orientation and key variables. The practical contributions of this research are diverse. The study also provides actionable recommendations for supply chain practitioners, policymakers, and industry stakeholders.

The study highlights the importance of resources namely digital orientation, supply chain integration, and interactions among stakeholders necessary for fostering innovation. These insights offer valuable guidance for companies confronting disruptions caused by the bullwhip effect and delayed innovation. The tendency for customers to increase the demand projections in response to uncertainties emphasizes the need for an integrated supply chain. Supply chain experts can apply these insights to develop tactics that reduce the impacts of the bullwhip effect, stressing the necessity of strategic collaboration to enhance internal, process, and product integration. This

strategy fits together with effective risk management practices, empowering companies to better handle the unpredictability brought on by the bullwhip effect.

In a competitive landscape characterized by shorter product life cycles and a demand for continuous innovation, involving all stakeholders in the exploration and exploitation of innovations is crucial for manufacturers operating on a global scale. Experts in supply chain management can leverage these insights to reassess and potentially recalibrate exploratory innovation and exploitative innovation in order to maximize the benefits of digital orientation. A strategic shift towards greater investment in digital orientation can be achieved by exploring and exploiting innovations, thereby strategically repositioning firms to enhance the financial performance. Adopting digital orientation and strategically managing innovations in both exploration and exploitation can be vital in an environment experiencing rapid technological change. Consequently, firms should consider the mediating effects of supply chain integration and the processes of exploration and exploitation innovation within the manufacturing sector.

In short, this study contributes to existing literature by offering supporting evidence. This study also expands on theoretical frameworks from previous research. The study explores the mediating roles of supply chain integration, exploratory innovation, and exploitative innovation. These factors influence digital orientation and enhance financial performance. The structural model developed in this study builds on earlier works, suggesting that supply chain integration, exploratory innovation and exploitative innovation are crucial links for leveraging digital operations to enhance financial performance. Furthermore, by analyzing the relationship between digital orientation, exploratory innovation and exploitative innovation, the study enhances our understanding of how the effective utilization of digital orientation can be driven by innovative mechanisms, thereby improving organizational financial performance.

Besides, this study not only validates the research framework but also broadens the discussion by providing an insightful view into strategies and practices in real-world supply chain management amid rapid technological change.

1.7 Operational Definitions

The operational definitions of the major key terms that are used in this study are stipulated in this section.

Digital orientation (DO)

Digital orientation refers to a firms' commitment to utilizing digital technology to deliver innovative products, services, and solutions (Khin & Ho, 2018).

Financial performance (FP)

In this study, financial performance refers to several measures, including return on sale, return on investment and profitability (Hendijani & Norouzi, 2023; Huo et al., 2014; Lu et al., 2018; Vickery et al., 2003, Ziaullah et al., 2017).

Supply chain integration (SCI)

Supply chain integration includes internal, process, and product integration. This involves strategic collaboration between an organization and the supply chain partners to streamline both internal and external processes. With this strategy, the flow of products, services, information, and financial resources becomes more efficient and effective (Hendijani & Norouzi, 2023; Hendijani & Saeidi, 2020; Koufteros et al., 2005; Huo et al., 2014).

Exploratory innovation (EY)

In this study, term 4 refers to the pursuit of new knowledge and development of new products and services for emerging customers or markets (Benner & Tushman, 2003; Danneels, 2002; Jansen et al., 2006).

Exploitative Innovation (EI)

In this study, term 5 refers to innovation that builds on existing knowledge and reinforces existing skills, processes, and structures (Abernathy & Clark, 1985; Benner & Tushman, 2002; Levinthal & March, 1993, Lewin et al., 1999). Exploitative innovation builds upon existing knowledge and skills, enhances current designs, improves products and services and optimizes distribution channels for better efficiency (Abernathy & Clark, 1985; Jansen et al., 2006).

1.8 Scope of the Study

While the manufacturing industry has long suffered from the bullwhip effect and delayed innovation despite extensive investment on digital orientation This research will delve into the relationships between key factors namely supply chain integration, exploratory innovation, and exploitative innovation, aiming to uncover how digital orientation can be harnessed to bolster financial outcomes. By examining these dynamics, the study seeks to provide insights into optimizing strategies for enhanced financial performance.

This study is limited to 3,600 manufacturing firms listed in the Federation of Malaysian Manufacturers (FMM) Directory. Based on Israel's (1992) guideline, the minimum recommended sample size for this population is 364. To account for the estimated response rate of 39.6% (Cook et al., 2000), 1,456 questionnaires were distributed through LinkedIn and email contacts extracted from the FMM directory. Data collection lasted for two months and resulted in 165 usable responses.

Although the final number of responses was lower than Israel's guideline, it exceeded the requirements of both G*Power analysis (minimum 85 responses for four predictors, $f^2 = 0.15$, $\alpha = 0.05$, power = 0.80) and the 10-times rule (70 responses for

seven structural paths). Therefore, the collected sample size is sufficient to achieve the statistical power required for the analysis

1.9 Chapter Summary

The chapter is the required background for the study. The chapter provides the context for the study and explains the purpose of the study. The chapter also presents the key issues that led to this study and specifies gaps within current knowledge.

The statement of the problem is clearly outlined, identifying the main challenges the study seeks to address. Research objectives are set to provide a structured focus, while research questions guide the investigation. These elements ensure that the study remains aligned with its purpose.

Key terms used in the study are also defined in this chapter. These definitions ensure clarity and prevent any misinterpretation of important concepts. A clear understanding of these terms is necessary for accurate analysis and discussion.

Overall, this chapter provides the context for the study. Chapter 1 encompasses the research background, problem statement, objectives, research questions, along with definitions of key terms. This chapter paved the way for the in-depth discussions in the following chapters.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature addressing the study's objectives. Section 2.2 explores existing research on the manufacturing sector. Sections 2.3 to 2.7 discuss the five constructs, namely digital orientation, supply chain integration, exploratory innovation, exploitative innovation, and financial performance. Section 2.8 reviews past research on Resource-Based View Theory and Stakeholder Theory. Lastly, Section 2.9 outlines the research framework, followed by hypothesis development in Section 2.10. The review brings together prior studies on all variables to highlight patterns and gaps that relate to financial performance.

2.2 Manufacturing Industry

During the industrial revolution and the latter part of the nineteenth century, the primary focus of manufacturing firms was solely on manufacturing itself. The manufacturers did not offer combined services nor did manufacturers exert control over the supply chains through vertical integration. Instead, manufacturing frequently relied on distributors and other intermediaries situated closer to the customers, placing them in a vulnerable position (Lamoreaux et al., 2002). In the late 1800s, gaining control over supply chains and integrating non-manufacturing service components became crucial for the success of certain firms. However, this vertical integration did not necessarily involve combining services with manufactured goods to cater to customers in innovative ways. Only a small number of firms managed to achieve both vertical integration and the bundling of goods and services for customer use. In the United

States, some manufacturing firms began bundling goods and services during the latter half of the nineteenth century. Prior to this period, there were clear distinctions between manufacturing firms and service firms, with distinct roles in the supply chain for manufacturers and those involved in marketing products or providing raw materials to manufacturers (Schmenner, 2004). During the late 1800s, advancements in mass production and the demand for widely distributed products led many renowned manufacturers to enhance the goods with specific services. This often involved integrating into distribution channels and, in some cases, extending control over purchasing and supply processes. As a result, previously separate steps in the supply chain, which were once handled as a silo function subject to market forces are now incorporated into integrated functions (Schmenner, 2009).

The industry is continuously having significant developments in technology. For example, the automation technology of the 1980s has led to flexible manufacturing (ElMaraghy, 2005) and the developments in artificial intelligence has led to progress in digital manufacturing (Jones et al., 2020). The manufacturing landscape has transformed from a centralized and single-product focus to a globally distributed approach, serving a wide range of products (Kusiak, 2020). Advancements in manufacturing process technology, computing, sensing, software technology, design methods, digital manufacturing, open manufacturing, manufacturing-as-a-service, shared manufacturing, sustainable manufacturing and resilient manufacturing have collectively facilitated the evolution (Kusiak, 2022).

Also, the manufacturing has experienced remarkable changes over time, particularly in the management of materials and information. The introduction of robotics and industrial automation has steadily enhanced the automation of material processing in manufacturing facilities. Similarly, information processing has also seen

automation through the integration of software programs that handle tasks such as material requirements planning and inventory management with more recent advancements in robotic process automation. These automation efforts, both in manufacturing and business operations, rely on the utilization of programs that employ procedural logic to replicate human decision-making processes (Sharma et al., 2021).

In the realm of manufacturing, undertaking innovation projects that involve significant changes to production systems is crucial for maintaining competitiveness in the future. Therefore, innovation, particularly for manufacturing firms, often possesses strategic qualities, such as defensive measures (comply with competition) to keep up with competition or even offensive approaches (taking advantages of competition) to gain a competitive edge. These decision-making and monitoring processes which are typically extensive and long-term, need to be based on well-established methods and metrics rather than vague data or blindly imitating competitors (Mamasioulas, et al., 2020).

In response to the 4th Industrial Revolution, known as Industry 4.0, the concept of inclusive manufacturing has emerged. It encompasses the integration of innovative practices and enhancements in the field to address societal, economic, and environmental challenges. These challenges include areas such as employment, labour, cross-border trade, trade policies, product and service costs, contribution to GDP, natural resource utilization, energy consumption and the development of sustainable products. Inclusive Manufacturing achieves this by leveraging geographically distributed resources and improved manufacturing technologies like IT systems, Artificial Intelligence, High-Performance computation, and Cyber-Physical Systems (CPSs). It combines the semantic web and the Internet of Things (IoT) to achieve objectives such as reduced time to market, improved product quality, lower costs, faster

services, and environmentally friendly manufacturing practices (Mamasioulas, et al., 2020)

In 2023, the manufacturing industry in Malaysia witnessed a significant digital investment amounting to RM 75 billion in global business services, IT and AI hub, software and automation application cloud. Malaysia also aims to groom 1.2 million of talents that specialise in digital technologies (MIDA, 2023). In this context, the FMM plays a pivotal role as a unifying platform for local manufacturers. The directory has recorded approximately of contacts of 3,600 manufacturers. The manufacturing sector is driving the economic transformation in Malaysia. Thus, the advancement of talent development and the adoption of Industry 4.0 technologies continue to be central priorities. Talent development playing a crucial role in revitalizing established industries while fostering new opportunities across diverse industries. In the manufacturing sector, firms are encouraged to improve productivity by integrating automation, fostering innovation, conducting Research and Development (R&D) and utilizing industry collaboration to discover the best practices (MIDA, 2023). By aligning with Industry 4.0 trends, digital orientation becomes a critical enabler that links technological change to improved competitiveness and financial performance.

2.3 Digital Orientation (DO)

Recent research has highlighted the importance of conceptualizing and analyzing a new strategic orientation (Khin & Ho, 2018; Kindermann et al., 2021; Quinton et al., 2018), namely a digital orientation. The digital orientation is a strategic approach of firm to making the most of digital technology opportunities (Khin & Ho, 2018; Kindermann et al., 2021; Quinton et al., 2018) such as the capture, transformation and the utilization of knowledge for value generation (Arias-P´erez & V´elez-Jaramillo, 2022). Digital orientation is strategic orientation that perceives digital resources as a

whole (Bharadwaj et al., 2013) which creates and fulfills expectations within the firm to obtain new digital resources (Eller et al., 2020) that in turn contributes to enhance digitalization. The technology orientation, learning orientation, market orientation and entrepreneurial orientation are digital orientation, the strategic orientation in the digitalization framework (Kindermann et al., 2020; Nambisan et al., 2019; Quinton et al., 2018; Schweiger et al., 2019). Digital orientation is defined as commitment of a firm to leveraging digital technology for the delivery of innovative products, services, and solutions. According to this characterization digitally oriented businesses are more open to adopting digital technologies, open to innovation, and quick to adopt digital initiatives (Khin & Ho, 2018). Kindermann et al. (2021) define the scope of digital technology which encompass technologies like sensors, blockchain, and IoT solutions, which serve as both contributors and results of digitization processes to achieve strategic growth. Firms that excel in digital technology scope enhance the products, services or solutions with digital technologies to add value to customers, cope with demands in market and explore additional revenues (Bharadwaj et al., 2013; Kindermann et al., 2021).

Bharadwaj (2000) views digital orientation as an IT capability embedded in firm resources. Khin and Ho (2019) view digital orientation as a strategic mindset that guides firms in seizing technological opportunities. Both perspectives are not contradictory. Instead, Bharadwaj (2000) and Khin and Ho (2019) complement one another by suggesting that digital orientation encompasses both technological capabilities and strategic intent. Taken together, this broader view offers a stronger foundation for examining digital role in driving other constructs in this study.

The manufacturing industry has embraced digital orientation with digital technology investments reaching more than $1.1 trillion a year across industrial