NEXUS AMONG KNOWLEDGE MANAGEMENT, ORGANISATIONAL AMBIDEXTERITY, INNOVATION CAPABILITY, AND MANUFACTURING PERFORMANCE: A STUDY IN IR4.0 FOCUS SECTORS

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CHEAH SENG CHEONG

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The great philosopher of the 20th century, Ludwig Wittgenstein, once said: *"knowledge is in the end based on acknowledgement"*. Implicitly, the findings of this research, through rigorous literature review and hypotheses testing, reflect its true meaning. Explicitly, it reflects my true feeling and thought on this journey of discovery. It would not be a success without the support of the following people.

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LIST OF ABBREVIATIONS

KM	Knowledge Management
EKS	External Knowledge Sourcing
KS	Knowledge Sharing
KA	Knowledge Application
KP	Knowledge Protection
IC	Innovation Capability
PRDINV	Product Innovation
PROINV	Process Innovation
OA	Organisational Ambidexterity
MP	Manufacturing Performance
RBV	Resource-Based View
KBV	Knowledge-Based View
DC	Dynamic Capabilities
IR4.0	Fourth Industrial Revolution

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HUBUNGAN ANTARA PENGURUSAN PENGETAHUAN, KEDWICEKATAN ORGANISASI, KEUPAYAAN INOVASI, DAN PRESTASI PEMBUATAN: SATU KAJIAN DALAM SEKTOR FOKUS UTAMA IR4.0

ABSTRAK

Sektor pembuatan Malaysia adalah salah satu penyumbang utama kepada keluaran dalam negara kasar (KDNK) tahunan, tetapi kadar pertumbuhannya menurun sejak beberapa tahun kebelakangan. Negara-nagara jiran pula memberi cabaran dengan kos buruh yang lebih rendah. Malaysia harus meningkatkan produktiviti melalui peningkatan sumber daya manusia dan penggunaan teknologi pembuatan yang ditawarkan oleh revolusi perindustrian keempat (IR4.0). Oleh yang demikian, kerajaan Malaysia memperkenalkan dua rangka tindakan IR4.0 untuk memudahkan penggunaan teknologi ini. Kajian ini bertujuan untuk menyiasat hubungan antara pengurusan pengetahuan, keupayaan inovasi, kedwicekatan organisasi dan prestasi pembuatan. Pengilang-pengilang besar daripada lima sektor fokus IR4.0 telah dipilih dan tinjauan dalam talian telah dijalankan. Sebanyak 145 data berjaya dikutip dan perisian IBM SPSS dan Smart-PLS telah digunakan untuk menganalisasi data. Kajian ini medapati kedwicekatan organisasi dan pengetahuan luar memainkan peranan penting untuk mencapai prestasi pembuatan dan keupayaan inovasi yang lebih baik. Pengetahuan luar, perkongsian pengetahuan dan perlindungan pengetahuan merupakan asas kepada kedwicekatan organisasi dan juga didapati mempengaruhi keupayaan inovasi dan prestasi pembutan melalui kedwicekatan organisasi secara tidak langsung. Implikasi teori dan praktikal juga dibincangkan. Kelemahan dan cadangan untuk kajian masa depan turut dikongsi bersama.

NEXUS AMONG KNOWLEDGE MANAGEMENT, ORGANISATIONAL AMBIDEXTERITY, INNOVATION CAPABILITY, AND MANUFACTURING PERFORMANCE: A STUDY IN IR4.0 FOCUS SECTORS

ABSTRACT

Malaysia's manufacturing sector is one of the main contributors to its GDP, but its growth rate has declined over the past few years. Challenge by neighbouring countries with lower labour costs, it has to improve its productivity by upskilling its human resources and adopting advanced manufacturing technologies that the fourth industrial revolution 4.0 (IR4.0) can offer. Realising the need to increase the adoption and diffusion of this new knowledge, the Malaysian government introduced two IR4.0 blueprints to facilitate the adoption of these advanced technologies. This research set out to investigate the relationship between knowledge management (KM), innovation capability (IC), organisational ambidexterity (OA) and manufacturing performance (MP) within this era. Large manufacturing firms from five IR4.0 focus sectors were selected for this study, and an online survey was carried out to gather the data. A total of 145 firms responded. IBM SPSS and Smart-PLS software were used for statistical analysis. The study reveals that OA and external knowledge sourcing (EKS) is key to achieving a better MP. Likewise, EKS and OA also positively impact IC. EKS, knowledge sharing (KS) and knowledge protection (KP) provide the basis of an ambidextrous organisation. EKS, KS, and KP were also found to impact IC and MP indirectly through OA. The theoretical and practical implications were discussed. The conclusion, limitations and suggestions for future studies were also shared.

CHAPTER 1

INTRODUCTION

1.1 Introduction

This study examines knowledge management, innovation capability, and organisational ambidexterity and their effect on Malaysia's manufacturing industry performance. This chapter gives an overview of Malaysia's manufacturing sector and its importance to the economy. Then it discusses the industry's issues in the advent of the fourth industrial revolution (IR4.0), which forms the problem statement, research objectives, and research questions. The rest of the chapter focuses on the study's scope and significance, defining key terms and the organisation of the chapters within this thesis.

1.2 Background of the Study

Malaysia's manufacturing sector has significantly contributed to its economic development (MITI, 2018). Over the past five years, it has consistently contributed 22 per cent of the total Gross Domestic Product (GDP), making it the second-largest contributor after the services sector (DOSM, 2019). According to the 11th. Malaysia Plan (RMK-11), the manufacturing sector attracted RM159.1 billion in investment between 2011 and 2014 (EPU, 2015). It also created 2.5 million jobs, or 16.1 per cent of total employment in 2018 (MPC, 2019). However, its average growth rate has declined for the last two years (2018 -2019) (MITI, 2018) and recorded an average of only 3.3 per cent growth between 2016 and 2020 (EPU, 2021b). The government is concerned because the growth rate deviates from the 5.1 per cent goal of RMK-11. Its contraction would affect employment rates, investment, and market prospects across the sector's supply chain (MITI, 2018).

Malaysia progressed from a low-income, commodity-driven economy in the 1970s to an upper-middle-income economy in the 1990s (MPC, 2020). It achieved that by embarking on a technological-demanding sector such as manufacturing. However, the manufacturing sector's continuous growth depends on one key indicator, productivity (MPC, 2020). According to the annual productivity report published by Malaysia Productivity Corporation (MPC), the latest 2021 report indicates that the country's productivity growth is on a downtrend and a cause of concern. The growth rate is already on a year-to-year decline for the past four years before it registered a negative 5.5 growth in 2020 due to the global Covid-19 pandemic (MPC, 2021). The 2021 report further cited rapid globalisation and disruptive technology as the main reasons. However, to further comprehend what contributed to the decline pre-pandemic, the researcher referred to the 2020 MPC report for more detail.

The 2020 report claims that such a result contradicts the belief that Malaysia has moved from a labour-driven to a capital-driven economy of higher productivity. Based on the Central Bank of Malaysia's (BNM) findings, such a declining trend is due to a significantly low capital stock per capita level compared to developed countries (MPC, 2020). The capital stock is the main driver for infrastructure and machinery upgrades to increase productivity. Moreover, most capital stock stays within the public sector instead of the private sector. As a result, firms rely on low-cost foreign labour as an alternative instead of investing in more quality and costly infrastructure that will increase efficiency (MPC, 2020).

The 12$^{th.}$ Malaysia Plan (RMK-12) also has identified productivity as a game-changer for the nation's growth. Productivity is key, particularly in the export-oriented

manufacturing sector (MPC, 2020). A drop in manufacturing production reduces export volumes that affect the country's economy (Lee, 2019). Moreover, the dynamic global value chain and technological advancement have resulted in complex products to meet changing customer behaviours (MITI, 2018). Compounded by the recent global Covid-19 pandemic, many aspects of daily life have changed profoundly. New business models surfaced and affected the manufacturing and consumption patterns (EPU, 2021a). Thus, to remain competitive, many global economies started to embrace the principles of IR4.0 (MPC, 2018).

Simultaneously, the World Economic Forum (WEF) and A.T. Kearney released a study entitled *Readiness for the Future of Production Report 2018* that assessed 100 countries' readiness to deal with IR4.0 (WEF, 2018). According to the study, artificial intelligence, robotics, and additive manufacturing can transform the manufacturing environment. It allows for higher productivity but poses new challenges in adopting them. Furthermore, these new technologies would enable a country to gain a competitive edge with lower manufacturing costs. The report also cautioned that each nation must analyse and comprehend the supporting factors and gaps in implementing these emerging technologies. Following that, they must develop the appropriate policies to address these gaps, without which they would be left behind.

With this in mind, Malaysia's Ministry of International Trade and Industry (MITI) unveiled the *Industry4Fwrd* National Policy on October 31st, 2018, as a blueprint for bringing forward a detailed amendment programme for implementing these emerging technologies to improve manufacturing operations and related services. As an organisation within the MITI, the Malaysia Productivity Corporation (MPC) aims to

promote projects that will increase national productivity by adopting IR4.0 (MPC, 2018). According to MPC (2018), IR4.0 is no longer merely a buzzword but represents a revolution toward using technologies to achieve higher productivity and quality without sacrificing cost or time. Changes in global trade and technologies further fuel the manufacturing firm's need to shift towards a more flexible manufacturing approach that reduces the delivery lead time (Cirera et al., 2021). As a result, to propel and sustain its future manufacturing productivity, *Industry4Fwrd* national policy also indicates that Malaysia must change rapidly and embrace IR4.0 as a critical operation strategy (MITI, 2018). Hence, such implications indicate the impending impacts on the MP.

The policy also highlighted other challenges that the manufacturing industry faces with IR4.0 adoption. One of them is the company's innovation capability (IC), which determines its capacity to respond to market demand dynamism by either changing production processes or launching a different kind of product (Lawson & Samson, 2001). Malaysia's 2019 global innovation index ranking is 35^{th,} and the goal is to strengthen to 30th by 2025 (MITI, 2018). This goal emphasises the government's desire to increase the global innovation index ranking, as higher rankings indicate the potential to implement more IR4.0 technologies (EPU, 2021a). However, at this time, the latest global innovation index (GII) ranking is 36$^{th.}$ (WIPO, 2021), indicating a downtrend, as shown in Table 1.1. Furthermore, Malaysia's ranking is still far behind other more matured emerging economies like China, Hong Kong, Korea, and even other ASEAN competitors such as Thailand, which is fast catching up. The gap with its closest neighbour, Singapore, is even more prominent.

Furthermore, Table 1.1 also revealed that the Innovation Input Sub-Index which made up of five pillars that represent aspects of the national economy that allow for innovative activities: 1) Institutions, 2) Human capital and research, 3) Infrastructure, 4) Market sophistication and 5) Business sophistication is showing a decline, whereas Thailand is gaining momentum and Singapore is at the top (WIPO, 2021). This area is of concern as it will affect the future Output Sub-Index result, which measures economies' innovative activities. It consists of two output pillars: 6) Knowledge and technology outputs and 7) Creative outputs (WIPO, 2021). In summary, there is a need for Malaysia to boost its IC to increase the productivity level of the manufacturing sectors and stays ahead of its rivals in attracting more foreign investments.

The national IR4.0 Policy also identified a few factors contributing to low IR4.0 technology adoption among manufacturing firms. The key contributors identified are a lack of appropriate knowledge, skillsets, requirements, cost-benefit analysis, and talent among local manufacturers (MITI, 2018). Besides that, the report claims that when it comes to innovation, many businesses also have a poor understanding of where to find the best expertise, how to spread the right information, such as success stories involving IR4.0 technologies, and how to defend their intellectual property. One of IC's most important facets is the firm's capacity to leverage technology by discovering emerging scientific knowledge and deciding how to use it for product or process improvement (Abdallah et al., 2016). Despite IC's positive implication, a recent study by the World Bank on the need for innovation in East Asia's development highlights a few contrasting findings. It indicates that activities related to KM are still lagging in most countries, including Malaysia (Cirera et al., 2021).

These findings reflect the need to embrace an innovative growth model and utilise innovation to improve efficiency and enhance the income for the firms to face these challenges. However, the indicators show that these countries underperform many innovation measurements, such as diffusion (adoption of existing technologies) or discovery (invention of new products, processes, or services). Again, Malaysia is one of the countries with low patent generation per capita (Cirera et al., 2021). Many of these countries are involved in the hi-tech value chain, yet their adoption of new technologies is still low. The reports indicate similar barriers identified by *Industry4Fwrd* national policy that suggest potential lag in KM-related activities: uncertainty and lack of information, lack of skilled workers, doubt about economic benefit, and lack of leadership in guiding technology adoption (Cirera et al., 2021). All these difficulties suggest that EKS, KS, KA, and KP play crucial roles in determining the right capabilities for firms to adopt technologies successfully (AlQershi et al., 2023).

On a global scale, Malaysia's manufacturing industries are gaining traction. Despite the unfavourable findings from the World Bank's study, Malaysia was ranked as one of two leading countries in Southeast Asia, alongside Singapore, with a large manufacturing base and a high potential for adopting IR4.0 and reaping its benefits (WEF, 2018). Despite its GII ranking of 36th other global survey studies describe Malaysia as a competitive nation with a balanced baseline condition for its manufacturing to bounce back after the pandemic (Cushman & Wakefield, 2021). Malaysia ranked 9th out of 47 countries in the Global Manufacturing Risk Index (GMRI) 2021 (Cushman & Wakefield, 2021). According to the GMRI report, Malaysia has the right business environment with competitive costs and minimal risk to support the manufacturing sector.

To improve all these rankings, the government, through MITI, continues to implement policies to encourage the implementation of IR4.0 technologies in the manufacturing sector (MITI, 2018), while the Economic Planning Unit (EPU) continues to focus on IR4.0 in general (MPC, 2020). The *Industry4Fwrd* national Policy specifically claims five potential sectors as the high-potential IR4.0 focus sectors: electrical and electronic, machinery and equipment, chemical, medical devices, and aerospace (MITI, 2018). Besides, the electrical and electronic, machinery and equipment, chemical and medical devices sectors were also identified by MPC as the main productivity nexus supporting the nation's growth (MPC, 2020). The electrical and electronic sector is regarded as the largest export revenue contributor and the leading sector to spearhead IR4.0 technologies (EPU, 2021a).

Within this background, this study has an important implication for developing strategic policies to encourage a higher adoption rate of IR4.0 technologies among manufacturers. The challenges highlighted earlier indicate that manufacturing firms generally face a mismatch of resources to achieve a balanced learning approach to enhance their knowledge and capabilities. At the same time, research has shown that organisational ambidexterity (OA) is critical for juggling on-hand resources to gain a competitive edge by reacting rapidly to evolving consumer demands (Kafetzopoulos, 2020). By practising OA, firms will mitigate the challenges during the implementation period, consequently improving MP. Thus far, as one can tell, no such study has managed to study the impact of MP from different research streams concurrently, especially in developing countries. With this in mind, the main objective of this study is to synthesise and empirically verify the impact of IC and OA on MP, with KM as the primary predictor.

Table 1.1 Malaysia Global Innovative Index Ranking Versus Other Countries for 2019, 2020, and 2021

	Global Innovation Index (GII) Ranking (2019: Total 130 Countries, 2020: Total 131 Countries, 2021: Total 132 Countries)											
	GII 2019	GII 2020	GII 2021	2020 vs 2021	Input Sub-Index 2019[a]	Input Sub-Index 2020[a]	Input Sub-Index 2021[a]	2020 vs 2021	Output Sub-Index 2019[b]	Output Sub-Index 2020[b]	Output Sub-Index 2021[b]	2020 vs 2021
Malaysia	35	33	36	↓	34	34	36	↓	39	36	34	↑
Singapore	8	8	8	↔	1	1	1	↔	15	15	13	↑
Republic of Korea	11	10	5	↑	10	10	9	↑	13	10	5	↑
China	14	14	12	↑	26	26	25	↑	5	6	7	↓
Hong Kong	13	11	14	↓	8	7	10	↓	16	16	17	↓
Japan	15	16	13	↑	14	12	11	↑	17	18	14	↑
Thailand	43	44	43	↑	47	48	47	↑	43	44	46	↓
Indonesia	85	85	87	↓	87	91	87	↑	78	76	84	↓
Viet Nam	42	42	44	↓	63	62	60	↑	37	38	38	↔
Philippines	54	50	51	↓	76	70	72	↓	42	41	40	↑

*Note: a = Innovation Input Sub-Index which made up of five pillars that represent aspects of the national economy that allow for innovative activities:

1) Institutions, 2) Human capital and research, 3) Infrastructure, 4) Market sophistication, and 5) Business sophistication

b = Output Sub-Index result, which measures economies' innovative activities. It consists of two output pillars:

6) Knowledge and technology outputs and 7) Creative outputs

Source: Cornell University et al. (2019, 2020); WIPO (2021)

1.2.1 The Advent of the Fourth Industrial Revolution

The preceding discussion highlights the importance of having IR4.0 technologies to improve the productivity of the manufacturing sector. This section provides further details as to how IR4.0 affect the global manufacturing landscape and how this will affect Malaysia's manufacturing sector. According to Damanpour & Evan (1984), environmental dynamism will trigger organisational strategy and structure change that usually leads to innovations. Generally, studies within strategic management perceive innovation adoption as a reaction to two situations, either proactively or reactively. According to Subramanian & Nilakanta (1996), organisations adopt innovation reactively according to uncontrollable external changing environment factors or proactively through strategic decision initiative by the organisation's decision-maker. Either approach requires changes to the characteristics and internal processes of the organisation. With the advent of IR4.0, the operation landscape of the manufacturing industry across the globe has changed. Moreover, the study on the adoption of advanced technologies pointed out that newer technologies enable a firm to increase its productivity and manufacturing capabilities. It is also essential for PRDINV and PROINV, which dictate their success (Narkhede, 2017).

Industrie 4.0 was first used in Germany at the 2011 Hanover fair (Drath & Horch, 2014). It refers to the fourth industrial revolution (IR4.0) the world is experiencing. According to Drath & Horch (2014), the first industrial revolution happened around the 1780s, when steam power revolutionalised production. The second revolution saw electric power usage move continuous production lines linked by conveyors. The third revolution saw the birth of the first programmable logic controller in 1969, which led to the usage of

electronic and information technology to automate the production system. Incorporating internet technology into the equation saw the interaction between the cyber world and the physical world using real-time bulk data to revolutionalise the production system, which forms the core of IR4.0 (Drath & Horch, 2014).

Through the application of this cyber-physical system (CPS) generic concepts, emerging technologies started to surface, such as the internet of things, artificial intelligence, robotics and additive manufacturing (WEF, 2018), which are also part of the eleven enabling technologies of IR4.0 (MITI, 2018). As stated in the 26th Malaysia Productivity Report 2018/2019, the nation maintains its projection growth of the economy between 4.5 per cent to 5.5 per cent. To sustain such a growth rate, Malaysia must focus on workforce development and adopt IR4.0 technologies to transform its job market (MPC, 2019). At the time of writing, the global economy is undergoing a difficult period due to the global Covid-19 pandemic wreaking havoc on its expansion. Despite the unique situation, the 2020 Malaysia Productivity Report stresses the need to enable larger and broader initiatives for the manufacturing sector to adopt IR4.0 as long-term productivity growth depends on technological advancement to have a strategic advantage (MPC, 2020).

Thus, RMK-12 put forth priorities and strategies that stimulate economic growth momentum by emphasising the development of new products or processes across all sectors through adopting emerging technology (EPU, 2021b). These strategies showcase the serious intention of the government to embrace IR4.0. The framework covers action plans to intensify the implementation of the strategic enablers that highlight inside the *Industry4Fwrd*. The growth strategy will focus on increasing the high value-added activities in the five key IR4.0 focus sectors, namely electrical and electronic, machinery

and equipment, chemical, medical, and aerospace. Measures will be put in place to enable the manufacturing sector to not only adopt IR4.0 technology but also focus on developing or incorporating them into their product (EPU, 2021b). All these measures were specifically formulated in response to the lacklustre performance results of RMK-11, especially in labour productivity growth, which registered a contraction of 0.2 per cent growth average between 2018 and 2020 (EPU, 2021b). Likewise, the NSI-8 revealed that manufacturing sectors still struggle to adopt high-order IR4.0 technologies such as autonomous robots, additive manufacturing, and augmented reality (MOSTI, 2020). As shown in Figure 1.1, most Malaysian manufacturing firms surveyed adopt less than 50% automation (MITI, 2018).

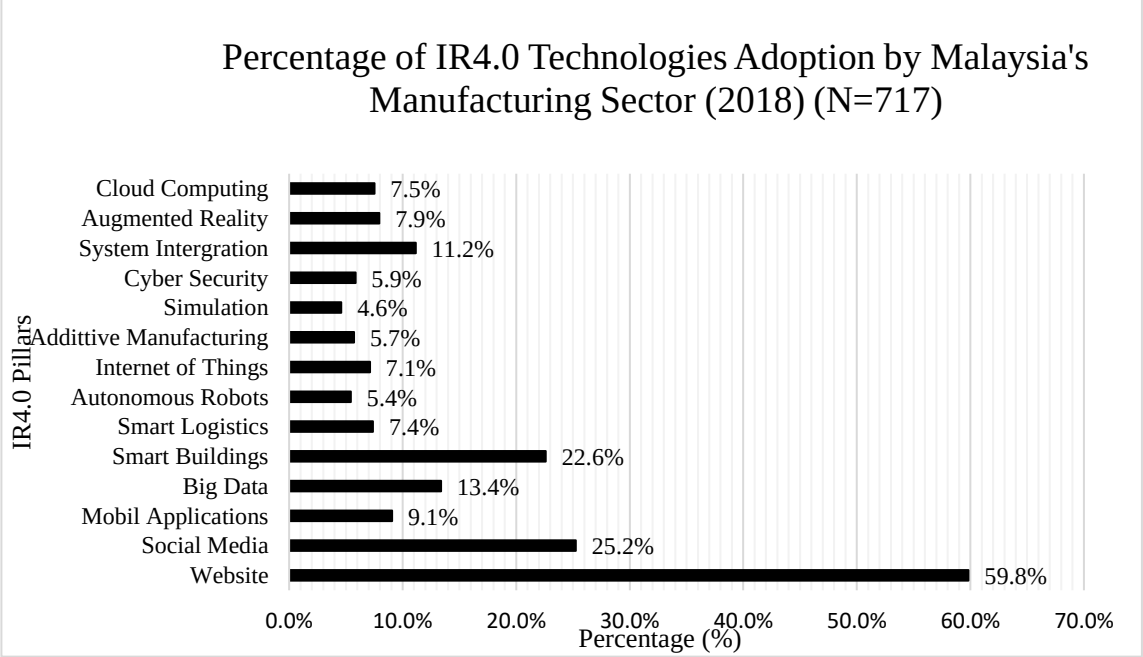

Figure 1.1 Percentage of IR4.0 Technologies Adoption by Malaysia's Manufacturing Sector (2018)

Source: (MOSTI, 2020)

Furthermore, the outlook of a post-Covid world implies a strong rebound in the global economy in 2021 and beyond. International Monetary Fund expected Malaysia to have a 9 per cent growth in GDP by 2021 (MPC, 2020). For the manufacturing sector to capitalise on the recovery, it needs to increase its effort to enhance its productivity. Adopting new technology, automation, and digitalisation is paramount for a resilient future (Cirera et al., 2021; MPC, 2020). According to the 2019 Malaysia Productivity Report, for Malaysia to accelerate its economic growth, the key is to increase its productivity in a smart way instead of the hard way. The arrival of IR4.0 revolutionises how physical and digital technologies converge to provide the traditional business model with a new perspective to enhance efficiency, optimise logistics and make costs more transparent (MPC, 2019). As a result, such technology-enabled platforms indirectly drive the country to formulate new approaches to increase productivity (MPC, 2019).

Thus far, the discussion shows compelling evidence that the advent of IR4.0 is inducing the development of modern processing processes and business models that will radically alter manufacturing. Such a change in technological advancement also brings forth new challenges and paradigms for manufacturing firms to maintain their competitiveness (WEF, 2018). As discussed earlier, adopting the latest technologies that IR4.0 can offer is no longer an option if an organisation wants to minimise its risk of losing its business. Simultaneously, countries need relevant national strategies to support the future of their manufacturing sector's production capability and boost their productivity level (WEF, 2018). The further insight gained from the *Future of Production Readiness 2018* report also revealed that government agencies, industry, academia, and

civil society need to take the right action to close the gaps toward making production a sustainable national capability (WEF, 2018).

1.2.2 The Importance of Manufacturing Performance

Simultaneously, the WEF's report claims that future production depends heavily on IR4.0 technologies to reduce production costs and increase flexibility to support higher customisation needs with enhanced quality (WEF, 2018). Such a claim is tantamount to the need for manufacturing firms to gauge their production and operational performance from the perspective of cost, quality, flexibility and delivery in their quest to improve their MP (Tan & Wong, 2015). Given such importance, the MPC states that performance management is critical to implementing IR4.0 since a detailed understanding of the performance and operational issues will determine the right IR4.0 solution to invest in (MPC, 2018).

Due to external factors such as sales or costs incurred outside the plant's control (McKone et al., 2001; Ramayah et al., 2004), high-level performance assessments such as organisational or firm performance that involve financial measurement may not reflect the real manufacturing capabilities (Szász et al., 2016). In this regard, manufacturing firms must consider the right measurement for their operation. However, this is another challenge many firms face in approaching IR4.0 with the traditional approach (AlQershi et al., 2023; MPC, 2018), such as using traditional accounting measures that emphasise financial measurement to measure their MP (Ahmad et al., 2019). Scholars who focus on analysing the performance of manufacturing firms from a wider scope tend to measure financial and non-financial indicators (e.g. Antunes et al., 2017; Darroch, 2005; Kafetzopoulos & Psomas, 2015).

The key difference between the performance of the manufacturing firm and MP relies on the need to include financial measurements. Since MP purely focuses on non-financial indicators, it is chosen as the study's dependent variable to gauge the firm's true capabilities in the era of IR4.0. Therefore, recent studies indicate that firms have started to focus on specific MP indicators to capture their true manufacturing capabilities and operational performance among the many competing priorities (e.g. Adebanjo et al., 2017; Ahmad et al., 2019; Tan & Wong, 2015).

1.2.3 Innovation Capability of Malaysia's Manufacturers

As discussed earlier, the advent of IR4.0 warrants manufacturing firms to have the right knowledge to adopt those advanced technologies. Likewise, firms with greater IC also tend to adopt such technologies. Recent studies in business management (e.g., Lei et al., 2019; Liao & Li, 2019) pointed out that IC is one of the firm's essential capabilities to face globalisation, the advent of new technologies, ever-changing customer needs and harsh economic conditions. Therefore, technological advancements have resulted in innovation's popularity as an essential capability to gain a competitive advantage (AlQershi et al., 2023). Malaysia is one post-industrial developing country facing a competitive threat from its rivalries (Tan & Nasurdin, 2011). To achieve sustainability in this dynamic knowledge-based economy, manufacturing firms must build up their ability to innovate successfully in terms of new products, ideas, practices, and systems as part of their operational strategies (Tan & Nasurdin, 2011). Innovation is considered the de facto element for productivity improvement and economic development (MOSTI, 2020).

In Malaysia, the latest *National Survey of Innovation* (NSI-8), which carried out a study from 2015 to 2017, provides the primary reference on the innovation trend and

statistics of the Malaysian manufacturing sector. NSI-8 indicates that through its survey of 717 manufacturing firms, only 38.4 per cent, or 275 firms, are active in PRDINV, and 39.2 per cent, or 282 firms, are focusing on PROINV. These figures signal that many manufacturing firms still find it challenging to pursue innovations. As highlighted by the report, another potential reason contributing to that is the firm size composition, of which 27.3 per cent comes from large firms and the rest are from small and medium enterprises. The 26th Malaysia Productivity report also claimed that large or exporting firms are more innovative than small or non-exporting firms (MPC, 2019). NSI-8 provides further insight by examining the abandoned and ongoing innovation activities trends between firm size and found that small businesses had the highest proportion of abandoned innovation activities (MOSTI, 2020). According to the survey, lack of top management support, high costs, a lack of financial aid, and market demands are all causes for project abandonment. These claims highlight the emphasis of this study on large firms and the need to identify the reasons for a lower abandonment rate for policymakers to provide an appropriate regulatory framework for the whole sector to excel in innovation.

In terms of national R&D strength, the 2021 GII study indicates that it is one of the key strengths of its input subfactor, ranking 37 globally out of 132 countries (WIPO, 2021). As gathered by the NSI-8 survey, most manufacturing firms consider the effective use of R&D spending as the most valuable innovation activity, whereas taking breakthrough technology to market is rated as the least important innovation activity (MOSTI, 2020). This finding aligns with the innovation objective, where many consider enhancing its existing product quality vital to meet its current customers' needs (MOSTI, 2020). It also suggests that the public sector spends more on R&D to develop

breakthrough technology, while the private sector is more concerned with product development (Cornell University et al., 2019). Such findings are more relevant to the firm's willingness to explore or leverage its resources, which is the subject of the next sub-section.

The high focus on improving existing products also resulted in many surveyed firms considering staff training as the most crucial innovation. They believe well-trained employees will develop innovative solutions to enhance product quality and productivity (MOSTI, 2020). While such an approach aligns with the KBV concept, where internal technical knowledge and skilled labour are considered essential resources (Grant, 1996; Migdadi, 2020), training the right skill set is a challenge, as reflected in MITI's *Industry4Fwd* Policy. There is a significant shortage of high-skilled workers with the necessary talent and knowledge to adopt IR4.0 digital adoption (MITI, 2018). NSI-8 also highlighted that manufacturing firms' least focused objectives are utilising incentives, grants, and loans. A staggering 74.7 per cent of the firms are unaware of government incentives to support such innovation activities (MOSTI, 2020). This finding suggests that many of these businesses struggle to manage their knowledge, which explains why the manufacturing sector's source of information is rated as moderately important in the survey.

The average mean score of below one on a scale of 0 (not relevant) to 3 (high) captured for all four major sources of knowledge: internal, market, institutional, and others, is an indication that manufacturing firms lacking in an exploratory sense (MOSTI, 2020). It is also an issue highlighted in the *Industry4Fwd* policy, where manufacturing firms have a limited understanding of their own needs or requirements to upskill their knowledge, let

alone embark on the IR4.0 transformation (MITI, 2018). As for protecting intellectual property, trademarks were the most commonly applied method, while industrial designs were the least commonly applied method (MOSTI, 2020). However, according to Oslo Manual, industrial design is vital for producing technological products and process (TPP) innovation activities (OECD, 2005).

The NSI-8 reports indicate that the Malaysian manufacturing sector's IC is on the right footprint but still warrants the stakeholders' focus on key areas to enhance the IC level and improve its competitive position. It highlights the need for appropriate policies to increase the knowledge resources, skillset, and ability to invest in machinery or tools of advanced technologies among manufacturing firms (MOSTI, 2020). As shown in Figure 1.2, an analysis of Malaysia's performance compares to the world's top three innovators suggests that there is still a big gap. Therefore, the Malaysian government needs to develop concrete policies to improve knowledge creation, industrial designs, online applications, and relevant training, which is crucial for improving the global innovative index ranking.

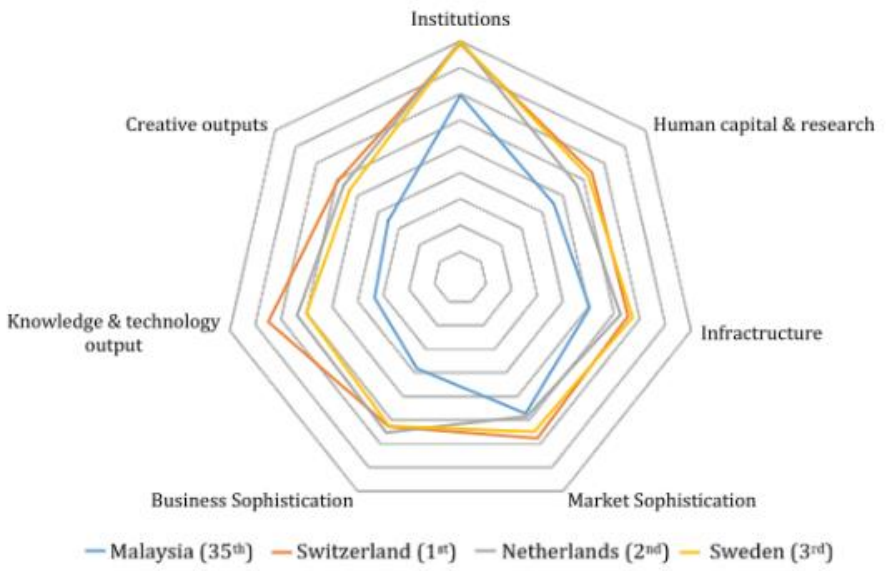

Figure 1.2 Performance Comparison of Malaysia with The Top Three Innovation Nations by GII Score

Source: MOSTI (2020)

1.2.4 The Importance of Organisational Ambidexterity

The last two sub-sections discuss firms' challenges when adopting IR4.0 and the need to increase their IC with limited knowledge and resources. This section discusses the importance of OA as a strategic management approach toward optimising on-hand resources to achieve maximum gains from adopting IR4.0. OA is "an organisation's ability to be aligned and efficient in its management of today's business demands while simultaneously being adaptive to changes in the environment" (Raisch & Birkinshaw, 2008, p.375). In a study on the impact of various management strategies on the organisation's innovation performance, Prajogo et al. (2004) and Prajogo & Sohal (2003) implied that organisations nowadays need to compete in different kinds of competitive dimensions. As a result, organisations must apply various resources to their operation to stay competitive. Among those resources, the skilled labour force embodies an innovative

firm's technological capability. Without skilled workers, a firm will not master new technologies, let alone innovate (OECD, 2005).

However, most companies have limited resources, yet employee knowledge and skills are the primary resources that define the firm's core capabilities that bring forth competitive advantage (Leonard-barton, 1992). The ability to optimise these resources is key to the organisation's success. In his well-known work on organisational learning, March (1991) concludes that a business needs to know how to handle exploratory and exploitative learning to remain competitive. Both of these learning aspects are discussed in great length in section 2.5, in brief, exploratory activities related to discovering new external knowledge, risk-taking, experimentation, flexibility, discovery, variation, and search (March, 1991). Usually, such a learning approach leads to radical innovation with a longer time in gestation (Raisch & Birkinshaw, 2008).

In comparison, exploitative activities focus on refinement, execution, implementation, production, choice, selection, and leveraging existing knowledge to improve efficiency (March, 1991) for short-term gains and enhance innovation incrementally (Raisch & Birkinshaw, 2008). Recent studies indicate that these activities complement each other and positively impact IC despite competing for the same resources (Liao & Li, 2019). Therefore, firms can remain competitive by optimising their resources to pursue incremental and radical innovation with both learning approaches. However, as discussed in the preceding section, the *Indusrty4WRD* Policy stated a few challenges most firms face in adopting IR4.0 technologies. The main barriers are lack of resources: cost, knowledge, skill set and the right human capital (MITI, 2018).

The *Industry4WRD* report also highlights the lack of awareness of the need and impact of IR4.0 technologies on the business model as a key challenge many manufacturing firms face (MITI, 2018). According to March (1991), such a challenge is a mismatch between exploration and exploitation learning. It is a condition where a firm is too dependent on refining its on-hand practices and being satisfied with current processes, causing it to be unable to search for alternatives or try new ways of doing things. The NSI-8 report confirms such predicament that Malaysia's manufacturing industry is facing. The report indicates that the manufacturing sector is uncomfortable exploring new frontiers or taking risks to elevate innovation activities.

Figure 1.3 represents the final result on the percentage of "Yes" and "No" responses towards the current innovation activities across the sector as reported in NSI-8. Activities related to the exploitation of current capabilities, such as internal R&D and training, are getting a higher implementation rate than exploratory-type activities, such as the acquisition of external knowledge, acquisition of R&D, and market introduction of innovation. Furthermore, the general reluctance by manufacturing firms to practise most of the perceived innovation activities is concerning. A very high percentage of the surveyed firms indicate "No" to critical activities that firms should implement to improve their IC and productivity.

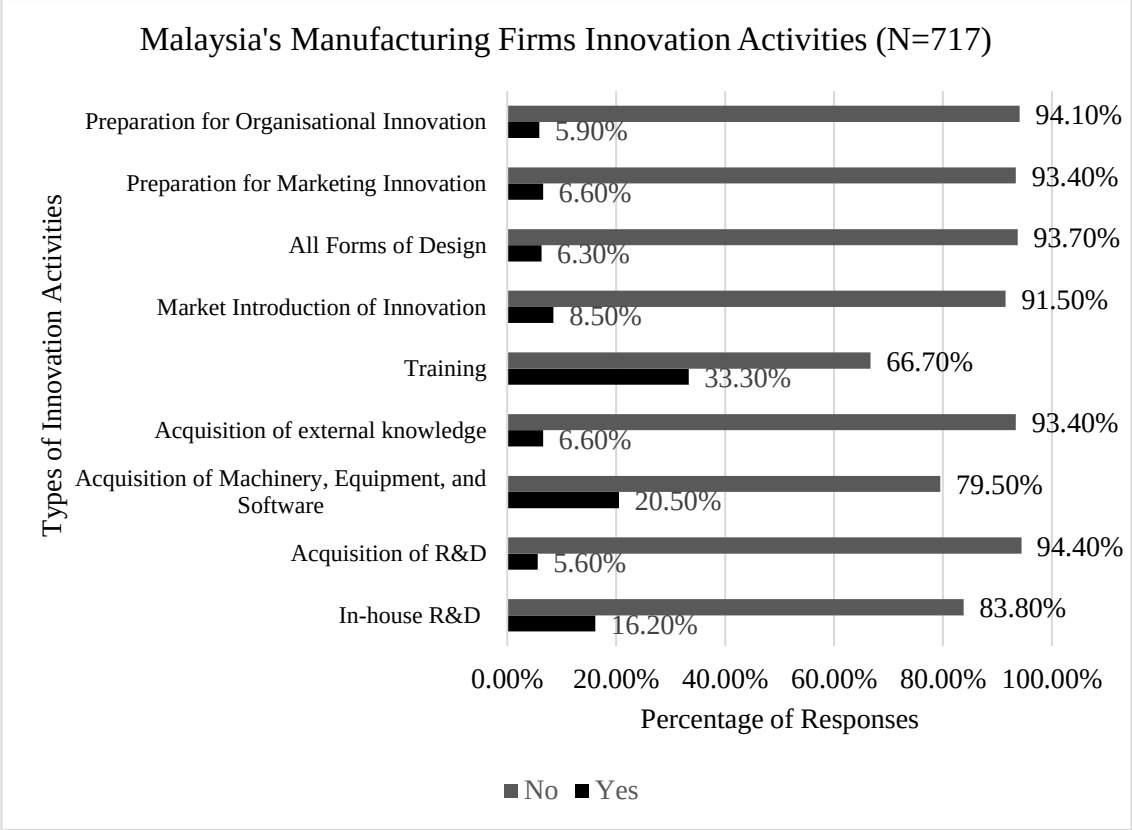

Figure 1.3 Malaysia's Manufacturing Firms Innovation Activities

Source: MOSTI (2020)

The 2020 Malaysia Productivity Report also revealed another disturbing trend. Capital deepening indicates the overall health of the nation's productivity growth, which refers to the investment in physical capital through purchasing or producing in-house to boost productivity. It specifically considers investments in information and communication technology (ICT) and machinery and equipment (M&E). As shown in Figure 1.4, Malaysia's capital deepening growth only registered a tiny increase of 0.2 per cent between the Tenth Malaysia Plan (2011-2015) and 2016-2019. Over the same period, capital stock (physical assets that help with production) grew slower at 3.8 per cent.

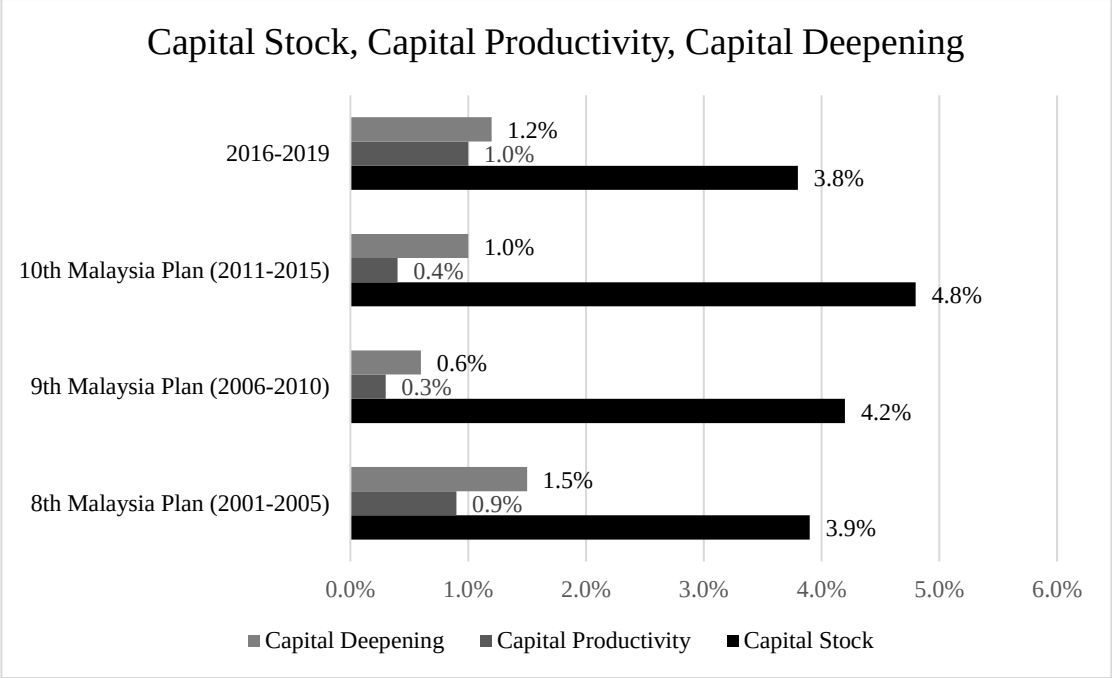

Figure 1.4 Capital Stock, Capital Productivity, Capital Deepening

Source: MPC (2020)

Furthermore, capital productivity is a metric on how effectively physical infrastructure is used to provide goods and services, only increased marginally at 1.0 per cent. These results indicate that the investment of physical assets only focuses on quality rather than quantity. In other words, this reflects the lack of exploration to adopting new advanced technologies and assets or being innovative enough to utilise new tools to improve productivity.

As a result, coming up with radical or breakthrough technologies and bringing them to the market have the least priority among the local manufacturing firms (MOSTI, 2020). Furthermore, according to NSI-8, different sizes of enterprises across the manufacturing industry displayed the same perception. On the other hand, they perceived the most important objective of innovation activities is to improve product quality, extend

the product range, or adhere to regulation standards (MOSTI, 2020). This perception coincides with the belief of the majority of the firms that customers' demand for quality is the top priority. OA literature explains this outcome by claiming that firms exploit activities they know well. Activities such as refining the products or processes to generate short-term rent rather than risking higher costs and new knowledge exploring uncertainties such as innovation development without a guaranteed return (Guisado-González et al., 2017; O'Reilly & Tushman, 2013). However, too many exploitation activities will potentially result in firms falling into a competency trap where they become too oblivious to environmental improvement and risk losing their competitiveness in the long run (Lin et al., 2013; March, 1991).

OECD Oslo Manual further explains the need to balance both activities by stating that innovation is central to determining national economic growth (OECD, 2005). At the firm level, innovation involves the capacity of a firm to explore and absorb new knowledge and exploit it to produce innovative output. It even stressed that innovative firms display two types of skills: strategic and organisational skills. Strategic skills refer to the ability of the firm to have a long-term view by identifying market trends with the willingness to source, process, and share technological and economic knowledge (OECD, 2005), akin to the exploratory process of an ambidextrous firm. Concurrently, organisational skills point to the ability of the firm to manage risk through internal collaboration between departments and cooperate with external parties to exploit changes within the firm (OECD, 2005). Thus, such claims indicate the importance of both exploratory and exploitative actions toward positive transformation for the firm.

Such a transformation is critical for manufacturing firms to face the fast-changing manufacturing environment that has driven global order over the past 25 years (Deloitte, 2016). The 2016 Global Manufacturing Competitiveness Index Report further reaffirms the importance of a firm's balanced approach towards optimising key drivers such as talent (knowledge), cost competitiveness, productivity improvement, and external collaboration towards achieving a conducive business environment in the wake of IR4.0. According to the report, based on the feedback of CEOs from global manufacturing sectors, there is a consensus that firms relying on a single point of leverage, such as cost advantage, to stay competitive is no longer true. Instead of relying on conventional short-term growth plans, businesses can actively explore new innovative technology, source and retain new talent, increase the use of specialised resources, and implement innovation tactics to succeed in this competitive environment (Deloitte, 2016).

When physical and digital manufacturing spaces converge, understanding how to execute the right level of exploratory and exploitative activities highlights the importance of OA. Drawing on the discussions from the literature, it appears that for manufacturing firms to sustain their business and achieve the right level of competitiveness, striking the right balance around a range of key drivers is not an option. Hence, ambidextrous capabilities are significant for these firms to compete in the foreign market or gain a competitive advantage locally (Zhou et al., 2016).

1.3 Problem Statement

The MP of the large companies determines their survival and development in Malaysia due to their high competitiveness. Although the manufacturing sector plays a vital role in transforming Malaysia into a prominent player in the global value chain (MITI,