

**AN ANTECEDENT-OUTCOME MODEL OF
RESPONSIBLE INNOVATION:
A RESOURCE-BASED PERSPECTIVE**

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RESPONSIBLE INNOVATION:
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by

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LIST OF ABBREVIATIONS

RI	Responsible Innovation
RRI	Responsible Research and Innovation
IR	Industrial Revolution
RBV	Resource Based View
SCA	Sustainable Competitive Advantage
ACAP	Absorptive Capacity
SME	Small and Medium Enterprise
CSR	Corporate Social Responsibility
ICT	Information and Communication Technology
TA	Technology Assessment (Organization)
NOTA	Netherlands Organization for Technology Assessment
ELSA	Ethical, Legal, and Social Aspects of Emerging Sciences (Organization)
DCA	Dynamic Capability Approach
HRM	Human Resource Management
R & D	Research and Development
VRIN	Valuable, Rare, Inimitable, Non-substitutable
PLS	Partial Least Square
SEM	Structure Equation Modeling
FMM	Federation of Malaysian Manufacturing
CB	Covariance Based
HCM	High-order Construct Model
AVE	Average Variance Extracted
HTMT	Heterotrait-Monotrait

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- APPENDIX A SURVEY QUESTIONNAIRE
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**MODEL ANTESEDEN-HASIL INOVASI BERTANGGUNGJAWAB:
PERSPEKTIF BERASASKAN SUMBER**

ABSTRAK

Firma tidak dibina dalam dunia yang terencil, dan juga tidak dapat bertahan tanpa penerimaan masyarakat. Firma bertanggungjawab ke atas tindakan dan inovasi mereka, walaupun inovasi tersebut dimaksudkan sebagai "inovasi sosial". Peningkatan kesedaran pihak berkepentingan ekonomi dan bukan ekonomi telah memaksa firma mencari penerimaan sosial dan etika untuk dianggap wajar dari segi sosial dan kognitif. Ia bukan lagi untuk mendapatkan keuntungan sahaja. Firma kini perlu menangani kebimbangan yang semakin meningkat mengenai inovasi teknologi yang akan datang, terutamanya mesin pintar buatan. Inovasi teknologi sedemikian mempunyai kesan serius terhadap autonomi, keadilan, dan agensi manusia. Pentadbiran kolektif dan bertanggungjawab berdasarkan beberapa nilai dan prinsip, melalui penglibatan awam dan wacana termaklum, boleh menyelesaikan isu tersebut. Penyelidikan mencadangkan "inovasi yang bertanggungjawab" (RI) sebagai penyelesaian kepada semua masalah ini. RI ialah pendekatan baru untuk mengurus inovasi teknologi yang menjadikan firma itu bertanggungjawab secara etika, moral dan sosial, mesra alam dan kemanusiaan selain berorientasikan perniagaan. Berdasarkan pandangan berasaskan sumber, kajian ini mencadangkan dan menguji RI secara empirikal sebagai kecekapan tersendiri firma yang dibangunkan hasil daripada sumber (ketara dan tidak ketara) dan keupayaannya, membawa ke arah kelebihan daya saing mampan (SCA) melalui kesan kontingensi kapasiti penyerapan, manakala prestasi kemampanan yang lebih tinggi (kewangan, sosial dan alam

sekitar) menjadi hasil akhir SCA yang diperolehi. Data telah dikumpul daripada sejumlah 190 syarikat pembuatan di Malaysia dan dianalisis menggunakan Pemodelan Persamaan Struktur Separa Kuasa Dua (PLS-SEM) melalui SmartPLS. Penemuan mendedahkan bahawa sumber dan keupayaan adalah penting dalam membangunkan RI firma, yang membina SCA yang akhirnya membawa kepada prestasi kemampanan firma. Antecedent RI yang paling penting ialah keupayaan penderiaan/tindak balas teknologi, diikuti oleh sumber kewangan, keupayaan membina hubungan dan sumber fizikal. Selain itu, peranan SCA dalam pengantaraan hubungan antara RI dan prestasi kemampanan telah diperakui. Akhirnya, kapasiti penyerapan juga meningkatkan hubungan positif antara RI dan SCA. Secara keseluruhan, penyelidikan ini menyumbang secara signifikan kepada memajukan badan kesusasteraan, menawarkan pandangan RI dalam konteks RBV, selain implikasi dasar.

AN ANTECEDENT-OUTCOME MODEL OF RESPONSIBLE INNOVATION: A RESOURCE-BASED PERSPECTIVE

ABSTRACT

Firms are not built in an isolated world, nor can they survive without societal acceptance. Firms are responsible for their actions and innovations, even if those innovations are meant to be "social innovations." Increased awareness of economic and non-economic stakeholders has forced firms to seek social and ethical acceptability to be considered socially and cognitively desirable. It's no longer about gaining profits only. Firms now need to address the rising concerns regarding upcoming technological innovations, especially artificially intelligent machines. Such technological innovations have serious impacts on human autonomy, fairness, justice, and agency. Collective and responsible stewardship based on some values and principles, through public engagement and informed discourse, may resolve such issues. The research proposes "responsible innovation" (RI) as the solution to all these problems. RI is a novel approach for managing technological innovations that makes the firm ethically, morally, and socially responsible, environmentally friendly, and humanitarian in addition to being business-oriented. Building on the resource-based view, this study proposes and empirically tests RI as a distinctive competency of the firm developed as a result of its resources (tangible and intangible) and capabilities, leading towards sustainable competitive advantage (SCA) through the contingency effect of absorptive capacity, whereas higher sustainability performance (financial, social, and environmental) became the end result of the SCA gained. Data were collected from a total of 190 manufacturing companies in Malaysia and analyzed using Partial Least Squares Structural Equation Modelling (PLS-SEM) via

SmartPLS. Findings revealed that resources and capabilities are crucial in developing the RI of the firm, which builds SCA that eventually leads to the sustainability performance of the firm. The most important antecedent of RI is technology sensing/response capability, followed by financial resources, relationship-building capability, and physical resources. Additionally, the role of SCA in mediating the relationship between RI and sustainability performance has been affirmed. Finally, absorptive capacity also enhanced the positive relationship between RI and SCA. Overall, this research contributes significantly to advancing the body of literature, offering RI insights in the RBV context, besides the policy implications.

CHAPTER 1

INTRODUCTION

1.1 Overview

The first chapter discusses the research background, research context, problem statement, research questions, objectives, and significance of the research. It starts by building a base for overall research while discussing the problem and the possible solution through the presentation of the concepts of the industrial revolution, digitalization, technological innovations as well as emerging technologies, which relate to corporate social responsibility and sustainability. The context of the emerging economy i.e., Malaysia has been discussed along with the need for responsible innovation among the manufacturing companies in Malaysia. After the study background and research setting, the problem statement was discussed. Then the research questions and objectives of the study are presented as per the research problem. Finally, the significance of the research, research contributions, and a brief regarding the organization of the remaining chapters are outlined.

1.2 Background of Study

The world is facing greater sustainability challenges concerning the availability of food & its security, aging population, inequality, poverty, hunger, pandemic, infectious diseases, climate changes, and energy demands, whereby all these are escalating (Voegtlin & Scherer, 2017). Distressingly, some scientists believe that some vital thresholds have already been reached and that the earth's life-sustaining infrastructure is in danger (Scherer & Voegtlin, 2020). The studies suggest

that climate change and other problems affecting the Earth's life-support system appear to be accelerating, despite worldwide attempts to alleviate these concerns (Rockström et al., 2021). Taking these dangers into account, there is a pressing need for sustainable solutions to reduce the impact on global security, health, and development (Buhmann & Fieseler, 2021).

The United Nations, the European Union, international organizations, and individual governments are all looking for ways to deal with these massive problems. Many projects have been launched to involve business organizations as active participants and promote collaboration between organizations, the public sector, and civil society actors in order to achieve sustainable growth (Ambos & Tatarinov, 2022). As a result, business organizations are now seen to be a part of such societal challenges, and they are expected to seek answers to these pertinent issues as socially responsible businesses. Governments are encouraging innovation, since innovation and technological advancements are considered to act as universal remedies to these enormous societal challenges (Lubberink et al., 2017). Furthermore, value for society is only created when innovation is implemented, and value creation is enhanced with the scaling of innovation (Lubberink et al., 2019).

The technological changes in society and entering into an era of industrialization especially manufacturing processes or inculcation of technological innovations like machines of that particular era is referred to as the industrial revolution. These transformations in industrial and technological processes continued to occur and kept on changing and now the world is entering into the new era of the fourth industrial revolution (Bartodziej, 2017).

The fourth industrial revolution (considered as IR 4.0) is leading the world to a newer phase of industrialization and technological innovations (Zhong et al., 2017). Across the board, significant organizational shifts have taken place with regard to their influences on value creation, the business model of the company, or downstream services (Sung, 2018; de Sousa Jabbour, 2018). In this IR 4.0 era, technological innovation will not only affect industrial manufacturing but human daily life as well when interacting with robots and artificially intelligent machines will become more common (Ekudden, 2018).

IR 4.0 has all the positive aspects; it can make manufacturing autonomously and smartly, flexible, accurate, efficient, and sustainable through its intelligent systems (Wang & Wang, 2016; Muller et al., 2018a). Furthermore, IR4.0 offers huge social benefits in almost every walk of life by performing tasks itself (through robotics), can reduce cost and time without human effort, provide standardization in services, and can help humans with menial and dangerous tasks (Muller et al., 2018b).

There are self-driving vehicles, and the next stage will be the automation of the entire civilization (Cath et al., 2018). On the contrary, societies will lose their democracy, autonomy, and self-government decision-making, and distinction, among other things (Helbing, 2019). There will be a great deal of reliance on these robots everywhere, where physical humans will be replaced by artificially intelligent machines, resulting in the loss of several human jobs (Memon & Ooi, 2021). This substantiates that the well-understood idea of sustainability is being faced by a technological revolution or transformation that refer to as the Industrial Revolution or Digital Transformation. Digitalization creates new options and avenues for

shaping the future of communal living, however, digitalization has implications for transparency and accountability, resulting in the emergence of totally new methods for shaping, monitoring, and governing sustainability (Zeng et al., 2022). To summarize, both megatrends, sustainability, and digitalization, force significant changes in reality and perceptions of it. Digitalization, in the end, will radically alter the architecture of our civilizations (Osburg & Lohrmann, 2017). However, till yet lesser attention has been paid to the negative impacts of such digitalization and the industrial revolution whereas the focus of earlier studies has been directed at highlighting the positive impacts of these technological innovations resulting in a huge gap in this subject (Piccarozzi et al., 2018; Muller et al., 2018a; Horváth & Szabó, 2019).

Hence, to ensure responsible citizenship, well-prepared and structured planning for technology breakthroughs with social, ethical, economic, and sustainability implications is of paramount importance. Understanding the interactions between IR 4.0 and sustainability is at the pinnacle. This study aims to contribute theoretical and practical perspectives into a relatively less explored area, by proposing the role of organizational resources and capabilities as the antecedents of RI, stressing the often-neglected business responsibility, which is anticipated to form a sustainable competitive advantage, and eventually yield a better sustainability performance.

1.3 Research Context - Malaysia as an Emerging Economy

Emerging economies like Turkey, Malaysia, China, Taiwan, Russia, India, etc. have become major players in the global economy over the last twenty years due to their exponential growth, drastic economic reforms, and impressive business

transition. Based on the obvious economic trends and expansion, these emerging economies have become strategic destinations for the direct investment of international organizations. While a significant amount of analytical work has been undertaken to uncover the origins of “miracle” progress in these countries, a lot of scholars (Khanna & Rivkin, 2001; Fatás & Mihov, 2009; Rodrik, 2011; Saleh et al., 2020; Law et al., 2020; Yadegaridehkordi et al., 2023) have concentrated on classical economic perspectives to explicate the basic reasons of success.

Within the emerging markets, Malaysia has been described as a broad emerging economy with various significant characteristics with regard to its geographical position, culture and socio-political stability (Law et al., 2020). According to the World Bank Report (2017), “The country is one of the world’s leading producers of consumer electronics and home appliances, technological and innovative products, motor vehicles, palm oil, shipping and transport machinery, building materials”. Hence, this study would now discuss the silent features of the Malaysian economy and its transition from a developing country to an emerging economy (to be considered as developed in the future after meeting required standards) whereas Malaysia has been ranked as #1 as a most attractive market in Asia, ranked #2 in ease of doing business among ASEAN countries, ranked # 2 among ASEAN countries with regards to global competitiveness (Lee et al., 2022a; Yadegaridehkordi et al., 2023). The research would also discuss the major and dominant innovative industries of Malaysia as well as the resultant problems concerning sustainability, to understand the need for RI.

1.3.1 Malaysian Economy Outlook

According to the 2017 Best Countries Report, Malaysia is ranked first among 80 nations in a survey regarding the best places to invest, surpassing rivals in the region like Singapore, India, Thailand, and Indonesia (Lee et al., 2022a). In 2014, Price Waterhouse Coopers (PwC) Escape Index announced that Malaysia had ranked itself as one of the emerging market giants, thereby getting rid of middle-income nation status. As the nation's overall Gross National Income (GNI) per capita revenue reached the global average of USD 10,000 in 2014, Malaysia effectively joined the developed emerging world league (Yong, 2017).

Malaysia's success in its current growth rate has not happened overnight. Not too long ago, the Malaysian economy was dominated by the industrial sectors that replaced the former agriculture market (Law et al., 2020; Yadegaridehkordi et al., 2023). From tin and rubber, the country has thrived with local businessmen and international manufacturers. Malaysia has been seen as a competitive location for investment in manufacturing due to its low labor costs, strategic position, good financial health, and environmental situation (Raguphaty et al., 2019).

The most influential business domains have been identified as food and beverage, wood products, rubber and plastics, textiles and clothing, and electrical and electronic goods. This industry, which has been the face of the country's contemporary corporate development for the past 25 years, has contributed to Malaysia's economic growth. The manufacturing sector has made important contributions to the nation, especially in terms of employment growth, productivity enhancement, greater foreign direct investment, and higher GDP (Ong et al., 2020). Accordingly, the Malaysian government decided to put into practice a strategy to

concentrate on industries with higher added value so that the nation can diversify its economy widely (Law et al., 2020; Lee et al., 2022a,).

Currently, the manufacturing sector, which accounts for 22 percent of the Gross Domestic Product (GDP), is expanding at a pace of 4.2 percent annually, with electrical and electronic products being the most produced (Al- Sharafi et al., 2023). Nevertheless, concurrent to the technological revolution, Malaysia's economic situation has transformed consumer demand and outlooks. The majority of nations have changed their corporate focus and market sectors from simple manufacturing to high technology.

With the launch of the high-tech sector, Malaysia has moved forward to develop a cyber-technology-based and digital landscape market, which has further provided an incentive for both large businesses and SMEs to join the digital industry. Accordingly, several initiatives have been put in place by the Malaysian government, showing an enormous improvement in the industrial sectors. The digital industry has been established across the country, especially in the small and medium-sized sectors. The establishment of MSC (Multimedia Super Corridor), MDeC (Malaysia Digital Economy Corporation) and recent Digital Malaysia (DM), MTDC (Malaysian Technology Development Company), and TPM (Malaysian Technology Park) projects reflect the government's support for setting up a digital platform in Malaysia enabling the organizations to contribute and cope with the challenges of upcoming technological revolutions in the business sector (Economic planning Unit, 2022)

1.3.2 Digitalization in Malaysia

Digital and innovative companies are now perceived to be one of the world's leading industrial markets in all areas of the world. The promise of becoming digital is far from being completely explored, it is claimed that the internet sector provides many possibilities for SMEs and larger organizations. Requiring a minimum investment outlay to be developed, this sector of the industry does not prevent even small and medium-sized businesses from receiving meaningful revenue streams.

Apart from offering a lucrative return for larger organizations and SMEs, this business model adds to national earnings and hence draws the government's consideration. The Economic planning Unit (2022) argued that digital business is being targeted in the country struggling to accomplish Vision 2025, as envisaged in Malaysia to be a knowledge-based and economy-based country. It explicitly reflects Malaysia's ambition to be a center for the digital industry in Asia.

The word digital enterprise used in this study applies to an enterprise that accepts, participates, and has proved to be a significant user of ICT or multimedia within a product or service range, hiring a large number of skilled and knowledgeable workers and constituted as a legal entity for qualified MSC operations/activities. In pursuit of Malaysia's vision for a knowledge-based economy, several steps have been initiated by the Malaysian government to promote digital enterprises, for example, MSC Malaysia grants certificates to accredited businesses that use multimedia and technology extensively in their firms, however, certain criteria are to be met for getting certified.

While the cyber industry has a lot to offer, it is still subject to a range of challenges. In order to avoid, the threats and risks that a digital enterprise can face

in Malaysia, a variety of policy measures have been designed by the government, to reduce the risk of fraud, data theft, virus attack, and hacking which can impact both companies and customers. As an influential leader in information development, Malaysia has been a member of the World Intellectual Property Organization (WIPO), the Paris Convention, the Berne Convention, and a Signatory to the Treaty on Trade-Related Aspects of Intellectual Property (TRIPS)

Cyber security Malaysia, an organization under the Ministry of Science, Technology, and Innovation, has been set up to track the national dimension of e-security. With the development and compliance of digital business established in the region, Malaysia is aiming to have an enticing bundle of security and risk reduction in the Asia Digital Region.

1.3.3 Malaysian Manufacturing Landscape

Manufacturing has been a keystone of economic prosperity in Malaysia for many years. Several products including rubber, palm oil and tin have contributed to this development, which has progressed over time. Nowadays, manufacturing accounts for 22 percent of the economy's GDP and is growing at a rate of 4.8 percent; electrical and electronic items have the biggest share of total output (Lee et al., 2022a). As of the end of November 2022, the Manufacturing sector in Malaysia reported sales of RM159.2 billion, an increase of 11.8 percent compared to the same month the previous year. A 6.1 percent rise in the Mining index helped push the Industrial Production Index (IPI) higher by 4.8 percent during the same time frame (DOSM, 2023; Al- Sharafi et al., 2023).

There are a total of 50,000 businesses in Malaysia's manufacturing sector; out of these, 97.14 percent are considered to be SMEs, while just 2.86% are considered to be large organizations. There are 46% micro-enterprises, 48% small-enterprises, and 6% medium-sized businesses, with a combined growth rate of 7.2% in 2022 and a share of SMEs' GDP of 21.5% (DOSM, 2022). There may not be much of a difference between the growth of large and small businesses in this sector, and the expansion of either may be tied to the health of the national economy. The local market is dominated by SMEs, but they have achieved this status by specializing in labeling and packaging-ready goods (Lee et al., 2022a; Al- Sharafi et al., 2023).

1.3.4 High-Technology (High-Tech) manufacturing industry

The recovery of the economy in more established manufacturing sectors is credited to high-technology industries. Innovation is linked to high-tech industries, and many of these industries and the businesses that make them up have just recently emerged. High-tech industries are inventive and rely on a highly qualified and technical labor force, yet they are also similar to other industries in other ways. This resemblance is demonstrated by the existence of large, multi-location businesses and branch plant production, cost-cutting pressures brought on by increased international competition, organizational and spatial separation of production facilities from locations with no regular administrative and innovative activities. Because of the technological capabilities and the highly skilled and qualified employees' rapid reaction times to changes in the business environment, there is no one definition of high-tech enterprises in the high-tech literature (Al-Lamy et al., 2020). High-tech companies have a reputation for reacting quickly to new chances to enter international markets, thus they must be informed of the most recent innovations and

cutting-edge facilities offered by rival companies. The idea of high-tech businesses is directly tied to their goods, their specifications, and their placement on the market because they typically market new or significantly improved items that are still in the consumer research stage. Vávrová (2017) “describes the high field as an ecosystem that cannot exist without R&D, technological advancement, the development of creativity, and the dissemination of information.” The author Zarzewska-Bielawska (2012) “describes the high-tech sector as an environment, which cannot exist without R&D, technology development, innovation development and knowledge development”. Additionally, given that the quantifiability of the popularly recognized high-tech sector criteria in this situation is not well established, a "transition band" will unavoidably be included in the classification of high-tech enterprises.

Table 1.1 below (OECD, 1997) classifies industries into four categories based on their level of worldwide technological strength: High-technology sectors, Medium-high-technology sectors, Medium-low-technology sectors, and Low-technology sectors.

Table 1.1
High-Technology industry classification

High-Technology Sectors	<ol style="list-style-type: none"> 1. Aerospace 2. Computers, office machinery. 3. Electronics-communications. 4. Pharmaceuticals
Medium-high-technology sectors	<ol style="list-style-type: none"> 1. Scientific instruments. 2. Motor vehicles. 3. Electrical machinery. 4. Chemicals. 5. Other transport equipment 6. Non-electrical machinery

Medium-low-technology sectors	<ol style="list-style-type: none"> 1. Rubber and plastic products 2. Shipbuilding. 3. Other manufacturing 4. Non-ferrous metals. 5. Non-metallic mineral products. 6. Fabricated metal products. 7. Petroleum refining. 8. Ferrous metals
Low-technology Sectors	<ol style="list-style-type: none"> 1. Paper printing. 2. Textile and clothing. 3. Food, beverages, and tobacco. 4. Wood and furniture

In Malaysia, Aerospace equipment, computers, telecommunication devices and technologies, advanced technologies based on CAM (computer-aided Manufacturing), CAD (computer-aided Design), CIM (computer-integrated Manufacturing), optical equipment, biotech, pharmaceuticals, laser devices, power and technical machines and equipment, etc. are all prime examples of high technology industries (Al-Lamy et al., 2020). Nonetheless, it is challenging to quantify how widely applied the aforementioned categories of technology are. Furthermore, we argue that high-tech manufacturing is the appropriate sample to reflect high-tech because, among other things, the use of technology differs from one sector to another and the size of the business is one of the important drivers.

The high-tech sector is currently Malaysia's most important economic contributor. In 2021, 38.2% of total export was comprised of electrical and electronic products, making them the top export category. As a result, there has been a shift in manufacturing towards high-tech sectors thanks to government aid for such businesses. The inadequate focus has been placed on the high-tech industry in Malaysia, despite its significance, and to yet, no research has been conducted to

determine how to best utilize information technology to stimulate innovation in the Malaysian high-tech sector. Since the high-tech industry is one of Malaysia's most innovative and knowledge-driven businesses, it also has the potential to play a key role in the era of 4.0 industries (DOSM, 2023)

1.3.5 Multimedia super corridor (MSC) and Malaysian economic growth

MSC Malaysia (formerly identified as the Multimedia Super Corridor and recognized as the MSC in Malaysia) is a special economic zone and a high-tech commercial area in central-south Selangor, Malaysia. The fourth Malaysian Prime Minister, Mahathir Mohamad, formally launched the MSC system on 12 February 1996. The development of the program was essential in order to drive the goals of Vision 2020 and to turn Malaysia into a new state by 2020 through the implementation of a knowledge-based society system. Later on, this plan was revised to 2025 due to the severe effects of Covid-19 on the economy (DOSM, 2023).

The Malaysian Multimedia Super Corridor (MSC) denotes Malaysia's strategies, initiatives and foundations that concentrate on developing a high-tech environment that intends to enable and draw foreign investors to open up their Malaysian ICT businesses that benefit from (one of the best communication and information technology infrastructure along with lucrative financial incentives and benefits) and Malaysia has been the most promising project for the global information and communications technology (ICT) industry since 1996, and Malaysia aims to lure the world's leading ICT companies with this special path (Saleh et al., 2020). At the national level, it aims to transform the nation towards a knowledge-based economy.

In order to meet the requirements of an MSC Company, the organization must be a supplier, manufacturer or strong user of multimedia goods and services. A large number of experienced employees (at least 15% of the overall workforce) will be hired by the business. The business can also render a clear value proposition by defining how it will contribute to the growth of MSC Malaysia in particular, and the world as a whole. These companies should create a separate legal body for MSC Malaysia qualifying activities and be based within the specified MSC Malaysia cyber cities or cyber centers (MDeC, 2020; Al- Sharafi et al., 2023)

To raise the number of MSC Status Organizations, the Malaysian government has provided a range of advantages to registered firms, including financial and non-financial opportunities. Financial benefits include complete exemption from tax legislative revenue for the first five years of the founding position of MSC Malaysian firms and 100 percent of the venture tax allowance (ITA) for innovative enterprises, rendering them qualified for R&D grants. Such R&D grants are only applicable to Malaysian-held MSC Malaysia-ranking firms. MSC rank businesses are granted the right to access funding and invest funds worldwide. Incentives are provided for the duty-free importation (DFI) of multimedia devices.

1.3.6 The impact of Covid-19 on the Malaysian economy and recovery

The COVID-19 pandemic has been a big problem for businesses in diverse fields of operations. All of these companies have been pressured to embrace new internal operating standards and have felt heavy pressure to deliver goods across digital platforms. Accordingly, Covid-19 has urged firms to quickly prepare themselves for the upcoming industrial revolution of 4.0 and thus Covid-19 has fastened the digital transformation process. Companies have undergone drastic

changes and have adopted innovations focused on emerging technology in a relatively short period. Around the same time, the modernization of governance and partnership models has been important to ensure that no one inside organizations is left unattended and lags behind this digitalization process (MDeC, 2020)

Digitalization also allows several businesses to adjust and solve the existing situation created by COVID-19. The increase in the use of technology in the everyday lives of individuals and businesses in the face of this extraordinary circumstance is proof of the digital acceleration phase (TechCollective, 2022).

Before the pandemic, Malaysia's exports of services grew dramatically between 2016 and 2019, to the point where the net deficit began to decrease in 2018, reflecting Malaysia's shift toward a services-oriented economy. Furthermore, although travel and transportation remain the two largest contributors, the rise in FDI in this country has prompted a more diversified trade in services, with new services like telecommunication, computer, and information, other business services, and charges for the use of the intellectual property. Several countries' economies, including Malaysia's, were significantly disrupted beginning in 2020 as COVID-19 wreaked havoc on healthcare systems around the world. Because of international travel restrictions, businesses tied to tourism and airlines in Malaysia struggled. Due to this, the travel and transportation industries, among others, saw a sharp decrease. At the same time, it can't be denied that Malaysia has seen firsthand how the pandemic has transformed daily life and the workplace thanks to the availability of digital technology. The usage of digital technologies was unavoidable given the prevalence of remote work and decreased need for face-to-face interaction. In 2021, ICT-related services have improved as a result of the progressive recovery of

business, health, and education via online platforms. Yet, COVID-19 had a significant negative effect on tourism exports, leading to a larger trade deficit in services (Al- Sharafi et al., 2023).

Malaysia's GDP expanded by 3.1% in 2021, up from a fall of 5.5% the year before, as the nation entered the COVID-19 pandemic recovery phase. Strong domestic demand growth, a declining unemployment rate, and continuous policy support through the deployment of various aid and stimulus packages all contributed to the positive effects of this recovery. Compared to the same nine-month period in 2021, Malaysia's economy grew by 9.3% in the first nine months of 2022. While all components of the expenditure side saw positive growth, led by Private final consumption expenditure, the robust performance on the production side was largely the result of expansion in the services and manufacturing sectors (DOSM, 2022). Now the Malaysian economy is continuously growing whereby the digital economy is expected to contribute to 22.6% of the GDP by 2025 (TechCollective, 2022).

However, the year 2022 saw the fastest annual increase of 27.8% in trade volume for Malaysia since 1994. This equates to a new high point. With a 25% increase from 2021 to 2022, exports outperformed expectations and reached RM1.6 trillion. As a result, the RM1.3 trillion in imports was up 31.3% from the previous year. For the 25th year in a row, starting in 1998, the trade surplus has increased, this time to a record-breaking RM255.1 billion (DOSM, 2023).

1.3.7 Malaysian manufacturing sector & need for responsible innovation

The Malaysian economic environment has parallelly shifted technology, changing business requirements and opportunities in keeping pace with the

technological transition since most countries have changed their market priority from production to a high-tech corporate environment. The G7 countries have started to explore and confirmed that using both the internet and technological resources will provide a country with wealth; Malaysia has not escaped this shift. An extensive ICT infrastructure in both public and private sectors is being developed and continuous work is going on, to realize the opportunities provided by technology and transform the country into a knowledge-based economy (Ong et al., 2020). With rapid industrial developments, Malaysia has experienced significant growth in recent decades. But today Malaysia faces problems of waste dumping, deforestation, air and water contamination despite a comparatively good environmental record. Similarly, the issues like other countries are also presumably increasing at a higher rate like economic uncertainty, sustainability, energy depletion, climatic changes, social issues, etc (Yadegaridehkordi et al., 2023).

Although the manufacturing sector plays an important role in the Malaysian economy, immense environmental and natural pressures have been imposed by phenomenal economic growth. The industrial sector is reported as the most important contributor to environmental concerns; many manufacturing industries generate waste and emissions and endanger lives on Earth. In Malaysia, the production of carbon dioxide (CO₂) is higher than the world average and other Southeast Asian nations, as a result of fast economic development and industrialization (Centobelli et al., 2020; Kraus et al., 2020). Further, there have been many cases in Malaysia of illicit waste disposal which has affected human and environmental health significantly and adversely. For example, the waste dumping into the Sungai Selangor resulted in a contamination incident that prompted the suspension of operations of many water treatment plants in the state. The waste of hydrocarbons

impacted almost 60% of the state's users by supplying drinking water, which involves almost 800,000 clients. In the surrounding area, the illicit disposal of hazardous waste from a Klang factory has created a heavy stench, which is supposed to pose health risks to locals and the public (Yusr et al., 2020).

Additionally, researchers have forecasted a temperature increase of 1.0–3.6°C by 2095 and an unpredictable trend in rainfall, albeit rainfall appears to be increasing by 2099, to be expanding throughout Malaysia. This has the potential to have a detrimental effect on the ecology, water resources, crop output, food security, coastal zone, public health, and business, among other things (Ooi & Amran, 2019). Climate change is recognized in Malaysia as having the potential to cause floods, resulting in socioeconomic loss, soil erosion owing to extended rainfall, decreases in agricultural output, as well as forestry, marine, and biodiversity loss owing to temperature fluctuations. This has increased serious environmental and sustainability concerns and may lead to devastating impacts if left unattended. Climate change's severe effects not only harm the environment for an extended length of time (landslides, exacerbated droughts, and flooding), but also cause substantial damage to property and even human lives. As a result, Malaysia's principal burden and obligation has been sustaining and lowering carbon emissions (Kraus et al., 2020).

To date, it has been widely accepted that the introduction of digital technology is necessary for technological catch-up and for fostering innovation throughout the 21st century. Adoption of new technologies could also address economic development, environmental problems and energy resource degradation uncertainties. Studies indicate that the key driver of long-term development is technological innovation (Ali et al., 2019). The growing concern about sustainable

growth, energy cost reduction and environmental problems are leading policymakers to identify domestic and global solutions (Yusr et al., 2020). Technological innovation, however, is seen as a "double-edged sword" in terms of helping to achieve sustainable development and in addressing environmental problems (Bekhet et al., 2018). Therefore, RI is the solution that should be focussed on rather than just technological innovation (Memon & Ooi, 2022a).

Additionally, it is argued that Malaysian workers spend 50% of their working day in repetitive tasks that can be automated through AI; it will also boost employee skills and free up workers' time for more interesting and worthwhile work (Al-Sharafi et al., 2023). In the next ten years, AI solutions are expected to increase the nation's Gross Domestic Product (GDP) by 26% (TechCollective, 2022). Rising automation in Malaysia may lead to the creation of 6 million new jobs by 2030, and this change in the nature of work will increase demand for in-depth education and distinctive skill sets globally (Al- Sharafi et al., 2023).

Malaysian Government is also keen now to adopt technologically innovative methods, for instance, the use of AMS (Advanced manufacturing systems), flexible automats such as CNC, CAD, and artificially intelligent robotics in manufacturing processes, and several measures have been taken as discussed above. So, it would require input factors beyond capital and labor to reach the expected annual growth rate. The best approach is a technological innovation by far; many scholars, clinicians and policymakers understand this (Ali et al., 2019) for the country's sustained development and competitive edge but performed responsibly (Memon & Ooi, 2021). However, Malaysian firms are still lacking in some areas for instance, non-configuration of resources and capabilities, non-compliance of international

standards for the environment, not meeting customer requirements resulting in dissatisfied customers, conventional methods in the production system and so on (Loong et al., 2019).

Accordingly, we argue that the RI is the need of the time due to immense demand by international customers, regulators, non-governmental bodies and society. Such responsible practices are now adopted throughout the world (Ong et al., 2020). The degradation of the environment and non-compliance to international standards may result in a loss of competitiveness and even the survival of the firms. So how innovation can be responsible and how it can be inculcated in manufacturing organizations? The answer lies in the optimum configuration and utilization of the firm's resources and capabilities. The dynamic capabilities view conveys that the firms must have dynamic capabilities through which they should realign their resources and capabilities to respond to external/environmental challenges (Iranmanesh et al., 2017; Yadegaridehkordi et al., 2023). Therefore, the said study would explore the resources and capabilities to be focussed on being a responsible innovative organization and gaining competitive advantage and higher firm performance.

1.4 Responsible innovation and emerging technologies

The concept of "responsible innovation" (RI) emphasizes the purposeful technique of stakeholder involvement as the primary mechanism for science governance, with the idea that these parties share and are jointly accountable for the development of future innovative products (Blok et al., 2015; Dreyer et al., 2017). Further, the responsible innovation (RI) approach suggests a set of techniques for increasing the responsiveness of innovation processes to societal concerns posed by

the inherent uncertainties, ambiguities, and hazards associated with new and developing technologies. RI has four dimensions which are anticipation, inclusion, reflexivity, and responsiveness (Stilgoe et al., 2013). RI as a whole (integrating all its dimensions) is considered as an umbrella term and is much broader than the previously initiated moves, especially in Europe, for instance, “Technological Assessment and Ethical, Legal, and Social Aspects of emerging sciences (ELSA)”. Similarly, the “Triple Helix Framework” of innovation includes the university-industry-government and “Quadruple Helix Framework adding “Society” as the fourth component. The integrated dimensions of RI not only cater to the social, ethical, and environmental aspects but these dimensions also include science governance applications (Memon & Ooi, 2022b). The focus isn't on the outcomes, but on the processes and inputs. This means that during the innovation process, all relevant concerns about social and ethical issues of the innovation that may affect health, safety, security, the environment, privacy, and other related values must be taken into account (Brand & Blok, 2019). Thus, it becomes a science governance mechanism that propagates the idea of making processes and inputs responsibly handled instead of being irresponsible and uncontrolled processes (Gwizdała & Śledzik, 2017; Lees & Lees, 2018).

The relevance of RI is emphasized more in technologically sophisticated nations, such as those in Europe, by the slogan of being prepared for the hazards associated with developing technology (Burget et al., 2017; Chatfield et al., 2017; Scherer & Voegtlin, 2020). RI entails predicting potential risks associated with diverse stakeholders' involvement in the early phases of innovation and actively reflecting on the impact of such risks on society (Stilgoe et al., 2013). The developing technologies targeted for RI are those that are expected to become

dominant paradigms during the next ten or fifteen years (Stahl et al., 2013). Nanotechnologies, big data, alternative energy sources, and genomics all have a history of contention (Memon & Ooi, 2021). Mertens (2018) emphasizes that RI for developing technologies has three main features. To begin, new technologies warrant evaluation due to their radical novelty and unpredictability. Second, an early appraisal is important to influence the trajectory of innovation. Thirdly, unforeseeable aspects must be foreseen in order to prepare for unanticipated situations. Thus, developing technologies can enable us to solve societal concerns in ways that are both sustainable and ethical (Scholten & Van Der Duin, 2015).

1.5 Problem Statement

In general, “innovation” is considered to be beneficent for society and this is what exactly is the commitment of the emerging field of “Responsible Innovation” (RI). However, not all technological innovations are “responsible innovations” (Brand & Blok, 2019), and thus the individuals, society and our eco-system are facing huge negative consequences (Zhang et al., 2019). For instance, due to IR 4.0 and related technologies, the world may face terrible consequences especially through artificially intelligent machines/robotics. Between 2020 and 2060, it is expected that artificially intelligent supermachines and computers will outperform humans in every aspect of life, according to renowned scientists and technological experts such as Bill Gates, Elon Musk, and Steve Wozniak, who are warning and considering it a great danger for humanity in the coming days (Dreyer et al., 2017; Helbing et al., 2019). These artificially intelligent computers have the potential to be more dangerous than atom bombs if they are employed recklessly and in a possibly hazardous way to pursue wicked goals (Winfield & Jiroka, 2018). Since hackers

infiltrated the Pentagon's and the White House's computer systems, there is no guarantee that robotics will not be misused (Helbing, 2019).

Additionally, there are more difficulties and uncertainties regarding the future effects of technological innovations such as those in biotechnology and nanotechnology (the current pandemic Covid-19, according to some scholars and scientists, is also seen as the result of such technological innovations), as a result of which the entire world is left stuck and powerless (Memon & Ooi, 2021). On the other hand, in order to better understand the difficulties, risks, and uncertainties involved, the enormous challenges of poverty, climate change, and sustainability issues, among others, call for a wide-ranging dialogue and the involvement of all stakeholders, as well as the formulation of some values and principles (Scherer & Voegtlin, 2020; Buhmann & Fieseler, 2021).

As a result, RI has become one of the most imperative and major fields of study, yet it has gotten little attention in scientific empirical research (Muller et al., 2018b; Piccarozzi et al., 2018). Since Europe has also been through crises, they now believe that innovation is the only path to sustainable, smart growth, and RI would establish the framework and policy for such innovation. However, RI has suddenly gained favor and momentum in response to this (Burget et al., 2017). As a result, RI has been employed as a method to help Europe through the current economic crisis, albeit the same may be said for Malaysia and other situations. For all of these dangers and sustainability problems, innovation with responsibility, or "responsible innovation," may be a solution. Particularly during this period of the world's abrupt transition to the new industrial era, the world needs to establish some principles and ethical/psychological constraints that should not only be able to manage this

disastrous situation but also ensure the business organizations regarding their profitability, higher market and financial performances (Scherer & Voegtlin, 2020).

Responsible innovation (RI) is a way of making sure that everyone who has an interest in a new product has a say in how it is made (Memon & Ooi, 2022b). RI uses the firm's resources and capabilities to become the firm's distinctive competency. Accordingly, RI may help the firm to achieve a competitive advantage and sustainability performance (Lees & Less, 2018). However, the firm needs to boost its absorptive capacity since the absorptive capacity of the firm acts as a dynamic capability and paves the firm's way toward competitive advantage (Wu, 2006). The concept of RI is so powerful and distinct that each of its dimensions can be a unique variable and requires many resources and capabilities to be grasped (The details regarding dimensions are discussed in the next chapter). These all dimensions require numerous resources and capabilities resulting in the construction of the firm's distinctive competency i.e., Responsible innovation.

Conversely, previous studies on RI are merely a prelude, coupled with the dearth of comprehensive empirical research and thus very little is known regarding its applicability for economic benefits and gains (Blok et al., 2015; Scholten & Van der Duin, 2015; Ribeiro et al., 2017; Lees & Lees, 2018; Lubberink et al., 2019; Zahoor et al., 2022; Memon & Ooi, 2022b). This ambiguity regarding the impact of RI on firm performance, its practical applicability as well as social and economic benefits are the most important reasons for firms' reluctance for adopting RI practices (Brand & Blok, 2019; Ko et al., 2020). Furthermore, the democratization i.e. deliberative engagement of economic and non-economic stakeholder in the technological innovation process, knowledge sharing, and inclusive governance