School of Management

A Longitudinal Analysis of Malaysia's Innovation System in Shaping Innovation Capability, 1965–2016

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Declaration

To the best of my knowledge and belief, this thesis contains no material previously published by any other person except where due acknowledgement has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any University.

Signature:

Date: 15 February 2022

Acknowledgements

"mata, pita, guru, daivam"

(mother, father, teacher and the divine)

With clasped hands and reverence, I wish to thank my mother, father (late) and my gurus, Professor Alan Fenna and Professor John Phillimore, and God for my Ph.D.

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Abstract

This thesis assesses the policies and strategies implemented by Malaysian policymakers from 1965 to 2016 in developing innovation capability. Malaysia became an upper-middle-income country relatively early due to its open economy and industrialisation efforts. Its policymakers pushed for it to become a high-income country by 2020 (revised to 2025), but that has proven elusive so far. Malaysia's economic predicament is between a rock and a hard place, as it is no longer an attractive alternative for foreign investors in either labour-intensive industries or innovative ventures.

This thesis evaluates Malaysia's innovation capability development through the innovation system lens, namely that a country with innovation capability will achieve economic success *ceteris paribus*. It tracked the interdependence and interactions of the various actors within the innovation system to determine whether they cohesively pursued the policymakers' intentions. In doing so, it considered the linkage between policies and strategies, established institutions and achieved outputs. These were evaluated by analysing the knowledge exchange, skills development, R&D and innovation activities. The focus was also on how these policies and strategies were implemented, monitored, evaluated, and corrected to ensure that the innovation system supported an innovative workforce development.

The thesis answered five interrelated questions. (1) What innovation policies and strategies were developed from 1965 to 2016 to build innovation capability? (2) Who were the actors established according to these policies and strategies?

(3) Were there interactions between these actors in achieving the targets of the policies and strategies? (4) How were these actors and interactions monitored and corrected from 1965 to 2016 to achieve the policy targets? (5) Can a correlation be drawn between these policies and strategies and innovation output during this period?

The thesis reviews the National Development Plans used by Malaysian policymakers to chart the country's economic development since 1965. The plans are an essential data source, as all Malaysian policymakers have used them, and they enable a rich longitudinal qualitative historical narrative to assess the approaches taken by the Malaysian policymakers in developing innovation capability. This narrative was triangulated with data from domestic and international organisations, commentary and critiques from economists, policy pundits, and scholars to understand the development of the Malaysian innovation system.

There are five key findings in answer to the research questions. First, all the developmental plans since 1969 have adopted the New Economic Policy (NEP) or a varied version of it — an ethnicity oriented affirmative action policy. This policy became path-dependent and hampered the development of the innovation system with non-economic considerations.

The second and third findings are interrelated: multiple actors were established without a clear indication of reporting structures. This approach has resulted in a convoluted innovation system with multiple actors acting in silos or duplicating efforts — a waste of resources. Evidence of clear interaction was not discernible from the data. There has not been much success in establishing a single conglomerate, body, or agency to promote economic activities. Fourth, there was evidently a lack of a systematic approach to monitoring, evaluating, and correcting the system's actors to achieve its economic goals. Lastly, the outputs e.g. the number of patent applications in selected key industries, i.e. electrical and electronics and automobile, reveal a mixed outcome. An output alignment for the electrical and electronics sub-sector can somewhat be established as opposed to the automobile sub-sector.

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1.1 Introduction

Since it attained higher-middle income status some 30 years ago, Malaysia's goal has been to become a high-income country by 2020. This ambition was operationalised by introducing the Vision 2020 plan in 1991 under the auspices of the sixth Malaysia Plan by the then Prime Minister, Tun Dr Mahathir Mohamad. Subsequently, all Malaysia Plans ('MP') had the achievement of high-income status by the set target as its primary goal. However, despite the policies and strategies implemented, as discussed in detail in the coming chapters of this thesis, Malaysia still has not made the transition to high-income status.

Generally, a country targeting high-income status needs to bridge the innovation frontier gap. Hence, developing innovation capability is widely seen as an essential ingredient in long-run economic growth (Furman, Porter, and Stern 2002, Cetin, Demir, and Saygin 2021, Bondarev and Krysiak 2021). The question that beckons answered here is whether Malaysia can bridge the gap at the innovation frontier and whether it has an effective innovation system to facilitate the development of this capability. By using the lens of innovation systems, this thesis posits that Malaysia may inch closer to its target if it ensures that its national innovation system is developed, monitored, evaluated, and corrected consistently to develop innovation capability, which in turn will assist in propelling Malaysia towards its targeted economic goal. This thesis aims to qualitatively trace the historical paths taken by the government to overcome the systemic failures that did or did not exist in the system through its innovation policies to build innovation/technological capability.

The proponents of innovation system studies suggest that the *market failure theory* does not holistically address the complexity of the innovation system and how innovation policies should be carved to overcome such failures. Instead, the better approach that these proponents posit is premised on the notion of *systemic failure*, which allows for a systems thought process and superior policy formulation by the policymakers. More of this debate is captured in Chapter 2. The incidental outcome of this study may lend insight into the ability of Malaysian policymakers to establish effective policies, measures, monitoring, and evaluation mechanisms in overcoming systemic failures. This insight may answer whether governments are competent to intervene or not.

1.2 Problem Statement

1.2.1 Malaysia's Economic Development Progress

Although Malaysia swiftly reached middle-income classification, it remains one of the few countries in Southeast Asia whose GDP per capita has remained between 20 percent to 40 percent below that of the United States for the last five decades (Lee, Lee, and Lee 2021, Lee et al. 2020, Raj-Reichert 2020, Cherif and Hasanov

2015a) leading to the conclusion that it is in economic stagnation. **Figure 1** displays Malaysia's GDP/Capita growth from 1960 to 2020. As highlighted in **Figure 1**, the growth was rapid from the early 1970s to the late 2000s, and thereon it has slowed down. Malaysia could not achieve the elusive $12,695[1] threshold signifying high-income status as of the end of 2020. **Figure 2** indicates the annual GDP growth rate since 2000. Between 2012 to 2019, it has constantly maintained a growth rate of 5 percent. However, the onset of SARS-COVID-19 has gyrated quite dramatically but shrunk overall, with a forecast of further shrinking in 2022.

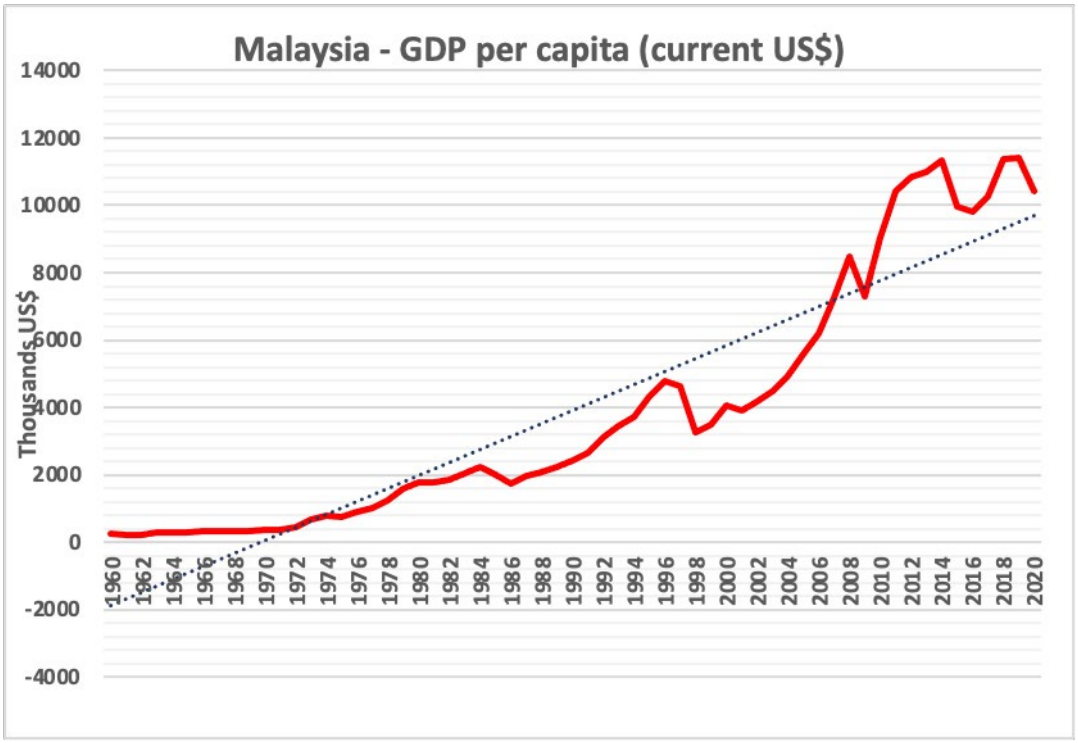

Figure 1 GDP Per Capita – Malaysia (Current US$)

Source: World Bank[2] Database

[1] As of July 1, 2021, https://blogs.worldbank.org/opendata/new-world-bank-country-classifications-income-level-2021-2022 (accessed on September 7 2021)
[2] https://data.worldbank.org/indicator/NY.GDP.PCAP.KD.ZG?locations=MY

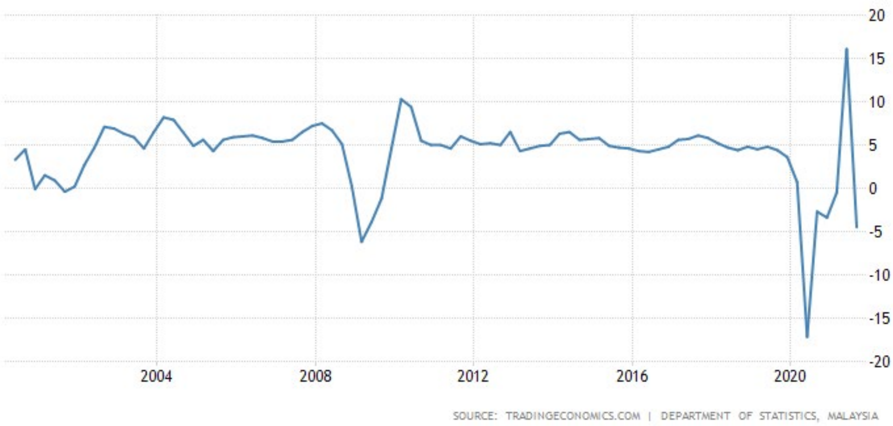

Figure 2 GDP Annual Growth Rate, Malaysia

Source: Tradingeconomics.com[3]

This growth trend indicates an inability to transition into higher value-added and knowledge-intensive processes (Tregenna 2015, Raj-Reichert 2020, Gomez, Cheong, and Wong 2021). It also indicates productivity stagnation (Doner and Schneider 2020) and a lack of competitiveness. Admittedly, since the time Malaysia transitioned into the higher middle-income status, only two countries have reached high-income status — South Korea and Taiwan Province of China[4](Jimenez, Nguyen, and Patrinos 2012). The change in income status of Korea and Taiwan from higher-middle income to high-income is notable, given that both economies started below Malaysia's income in 1970 (Cherif and Hasanov 2015b, Suehiro 2019, Ozturk 2016). Between 2010 and 2020, Malaysia's GDP per capita increased from USD$9,040 to $10,401, a mere increase of $1,361 compared to Korea, which increased from USD$23,087 to $31,489 an increase of

[3] https://tradingeconomics.com/malaysia/gdp-growth-annual#:~:text=GDP%20Annual%20Growth%20Rate%20in,the%20second%20quarter%20of%202020.

[4] Hereinafter referred to as Taiwan

$8,402 during the same period, as shown in **Figure 3**. This comparative snapshot of growth patterns between Korea and Malaysia depicts that Korea has surpassed Malaysia's progress, although both countries started on an even footing. Whilst there is no lack of effort on Malaysia's part, the reason for its slow progress requires further exploration. This study aims to elucidate the plausible reasons by studying the policy and strategy patterns adopted by the Malaysian policymakers and identifying policy lock-ins within the innovation system (if any) to explain the situation.

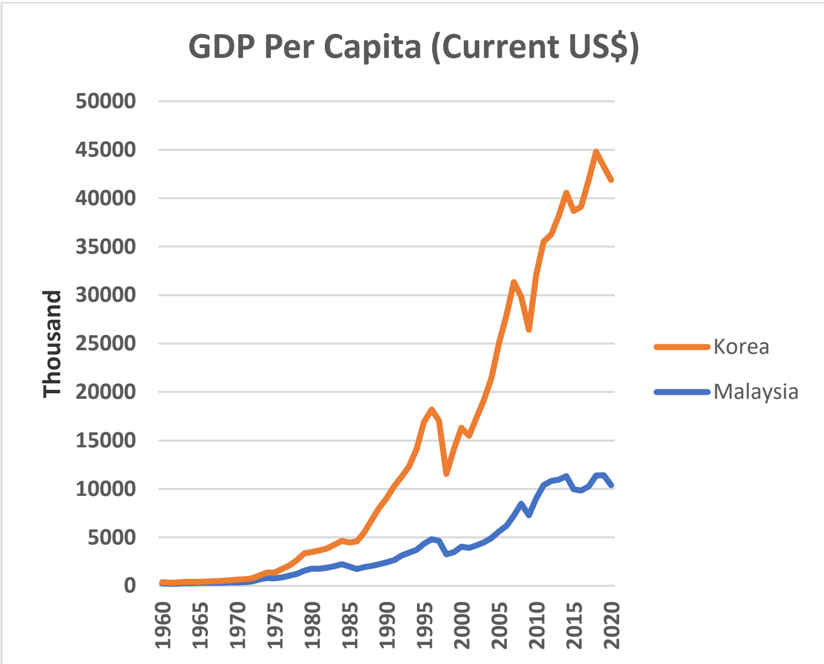

Figure 3 GDP Per Capita Comparison between Korea and Malaysia, 1960-2020

Source: World Bank Database

1.2.2 Critical role of innovation in driving economic growth and development

Innovation is a significant propeller of economic growth and facilitates competitiveness. Numerous studies have been undertaken to determine the contribution of technological changes to economic growth from the initial study by Solow in 1957, both theoretically and empirically (Cainelli, Evangelista, and Savona 2004, Wong, Ho, and Autio 2005). Studies on innovation initially started with the notion that innovation was exogenous in that technological knowledge was a public good that was freely available and was regulated by the market (neo-classical theoretical concept). However, this notion was proven to be inadequate, particularly when involving innovation where such knowledge is not freely available as (1) it depended on the capability of the actors within the system and (2) the market was not equipped to regulate it. This limitation burgeoned the endogenous growth models, emphasising knowledge, its spillovers and technological replacements in the economic growth equation (Wong, Ho, and Autio 2005, Fagerberg, Srholec, and Verspagen 2010, Bondarev and Krysiak 2021). This model is developed on the basis that income levels and growth are determined by capital (both human and physical) and factor productivity (technology) (Tebaldi and Elmslie 2008).

To determine growth by using the innovation concept, researchers have used various measures as input factors, such as R&D expenditures, patents (Wong, Ho, and Autio 2005), the technological balance of payments, machinery imports(Cameron 1996) and technical personnel (Fagerberg, Srholec, and Verspagen 2010). These measures were chosen for empirical analysis due to the ease of obtaining data. Measuring innovation meaningfully is a difficult task as its main limitation is data availability and reliability. Some of the more difficult concepts are almost often neglected in these analyses, one of which is considering organisations and institutional changes and capabilities of firms, industries, and countries (Fagerberg, Srholec, and Verspagen 2010, 2). Given the complexity involved in the concept surrounding innovation, the innovation systems study was introduced to consider the interactions of the various actors within the system in promoting innovation. However, theoretically, this area of study is one that is fast evolving, given its complexity. The discussion of the theoretical aspects of innovation, innovation systems and its difficulty to be captured as a theoretical concept is highlighted in Chapter 2.

As alluded to, since measuring capability empirically is challenging, attempts to measure technological or innovation capabilities or innovation systems have often involved various factors aside from patents. **Figure 4** below shows some of the measures that researchers have used.

Dimension	Measure
Science, research and innovation	Scientific publications, patents, R&D (total/business), innovation counts
Openness	Openness to trade, foreign direct investment, research cooperation/alliances with foreign partners, technology licensing, immigration
Production quality/standards	International (ISO) standards, total quality management (TQM), lean production, just-in-time
ICT infrastructure	Telecommunications, internet, computers
Finance	Access to bank credit, stock-market, venture capital
Skills	Primary, secondary and tertiary education, managerial and technical skills
Quality of governance	Corruption, law and order, independence of courts, property rights, business friendly regulation
Social values	Civic activities, trust, tolerance, religious ethics, attitudes towards technology and science

Figure 4 Measuring Capabilities

Source: Fagerberg, Srholec, and Verspagen (2010, 9)

In this thesis, the dimensions of science, research and innovation and skills will be considered in evaluating innovation / technological capability development in Malaysia. This is elaborated on in Chapter 5.

1.3 Identifying the Gap

1.3.1 Sustained Economic Growth

Studies examining how to sustain economic growth remain relatively underexplored within long-term economic growth research (Lee, Lee, and Lee 2021). This lack could be attributed to the complexity of factors contributing to economic growth and sustainability. However, Schumpeter propositioned that innovation induces “creative destruction” in that it disrupts the equilibrium within the economy to prompt economic growth (Cristescu and Nerișanu 2021). Hence, Schumpeter suggested that innovation activities are essential to achieve economic growth. On this premise, this thesis investigated Malaysia's innovation capability policies and strategies to bridge the gap at the innovation frontier, which may pivot Malaysia to achieving its long-term economic goal – high-income status.

1.3.2 Malaysia’s National Innovation System – Innovation Capability Development Review

The development of indigenous innovation capability is significant (Chandran and Devadason 2017). Appreciating the importance of innovation capability, the

Malaysian government pursued technology policies, but these policies did less to institutionalise public-private linkages (Ritchie 2005, Rasiah 2002). There is a discord between the coordination and cooperation of technology policies in the Malaysian context. This discord has deeper rooted ethnic considerations, as highlighted by literature (Chandran and Devadason 2017, Rasiah 2002, Jomo 1998). Besides ethnic considerations, observers cite lack of skills (Ritchie 2005, Chandran and Devadason 2017); fragmented institutional structure (Chandran and Devadason 2017); weak institutional support (Rasiah 2006); poor quality and less effective policymaking abilities (Ritchie 2005, Jomo 1998, Chandran and Devadason 2017); and poor policy implementation and evaluation processes (Rasiah 2006), as contributing to the Malaysian situation. Where the institutions are locked in, it will almost always be challenging to move to the next level of development.

1.4 Purpose of the study

Innovation system analysis involves investigating the relationships between the various actors responsible for creating, diffusing, and using knowledge and innovation (Lee et al. 2020). The innovation system concept has been analysed through national, regional, cluster and even at the firm level. It is postulated that the effectiveness of this system at whichever level is considered will determine the country's innovation and economic performance. If the actors within the system are not aligned, there may be a system failure (*systemic failure*), and this needs to be identified and rectified to achieve a country's economic goals (Lee, Lee, and Lee 2021) otherwise it runs the risk of closing down existing technologies and preventing technological development (Park and youn Kim 2021). Similarly, capability failure is where limited indigenous innovation capability prevents adoption, conversion, socialisation, externalisation, combination and internationalisation necessary for national innovation and foreign technology (Park and youn Kim 2021).

The National Innovation System (NIS) framework here is used to understand the general patterns of Malaysia's innovation capability development path, conditioned and shaped by historical considerations and how that, in turn, impacted economic development. This study used Malaysia's medium-term indicative development policy documents (Malaysia Plans) as the primary data source. Other relevant supporting documents were solicited to understand the interactions between the various actors involved in developing capability.

1.4.1 Framing the research question

The importance of innovation capability, as discussed above, cannot be understated. The concept has been presented in four different forms of capabilities: innovation system, governance; political system; and openness (Ambashi 2017).

The innovation capability approach adopted in this thesis is the innovation system form. The common denominators used to measure this capability have included patents, science and technology publications, standards certification, internet and mobile users, school enrolments and others (Ambashi 2017). A pivotal study by Fagerberg and Srholec (2008) established a positive correlation between innovation systems and economic development. Hence, enhancing innovation capability will assist Malaysia to significantly bridge the gap in the catch-up phase to becoming a high-income country. This thesis aims to understand the general policy and strategy patterns used to develop innovation capability in Malaysia to explain the roles of the various actors in the innovation system, their interaction, and how these were monitored and corrected.

1.4.2 Research Questions

This study aims to identify and trace the innovation system development policies and strategies introduced and implemented by the Malaysian policymakers to nurture innovation and technological capability in Malaysia. It aims to elucidate the possible policy lock-ins that may or may not exist and how these, if they existed, were monitored, evaluated, and corrected.

Hence, this study traces Malaysia's National Innovation System policies and strategies from 1965-to 2016 in shaping innovation capability. To achieve this aim, the following research questions were examined.

(1) What innovation policies and strategies were developed from 1965 to 2016 to build innovation capability?

(2) Who were the actors established according to these policies and strategies?

(3) Were there interactions between these actors in achieving the targets of the policies and strategies?

(4) How were these actors and interactions (if any) monitored and corrected from 1965 to 2016 to achieve the policy targets?

(5) Can a correlation be drawn between these policies and strategies and innovation output during this period?

1.5 Methodology

By employing a longitudinal qualitative method, this thesis analysed Malaysia's approach to developing its innovation capability to answer why Malaysia struggles to bridge its innovation / technological gap to move to the next level of economic development. In doing so, it examined the policies and strategies related to education and training, R&D, and creation and changes of institutions, agencies, firms, organisations, and regulatory frameworks as found in its National

Development Plan as proxies for establishing innovation capability, which is fundamental for an innovation system, and that in turn is the key to understanding why there is an economic developmental lag or economic stagnation. Most certainly, for Malaysia and countries in a similar developmental stage, achieving high-income status will mean higher earnings, better life quality, and a competent workforce (Hendrick-Wong 2020). Further discussions on the research methodology and conceptual framework employed in this thesis will be discussed in Chapter 5.

1.6 Significance and contribution of this study

There is a dearth of research undertaking long-term analysis of policies and strategies in Malaysia aiming to study the innovation capability development paths. The assumption that is made in this thesis is that innovation capability contributes to economic development *ceteris paribus*. The narrative approach adopted in this thesis is unique in that it delves through a longitudinal analysis of the main policy document, i.e., the Malaysia Plans and is supported by other secondary data, to triangulate information and ascertain whether or not Malaysia has a system that is conducive to build innovation capability or suffers a systemic failure. This study also aims to identify possible lock-ins that may impede the effort of developing innovation / technological capability that is causing the technological / innovation bottleneck for Malaysia and can be used as a guide to address those lock-ins effectively.

1.7 Structure of the thesis

This thesis has nine chapters. This Chapter discusses the justification for this research, gaps, research question, and conceptual framework. It lays down the aims and goals of this thesis. Chapter 2 provides a foundational overview of innovation, its theoretical challenges, and the contribution of systems ideas to economic development. Chapter 3 reviews the best practices of successful innovating countries, i.e., Sweden, Japan, and Korea, in adopting, implementing, and evaluating public policies encouraging innovation.

Chapter 4 describes the Malaysian political economy and critical national policies, institutions, and plans. This is followed by Chapter 5, which discusses the research methodology and methods employed in conducting this qualitative research. Chapters 6 and 7 identify and elaborate on the data used for this study. Next, Chapter 8 contains the data analysis identified in the preceding two Chapters. Finally, Chapter 9 discusses the findings of the research questions, policy implications and recommendations, notes limitations, and concludes with recommendations for future research.

Chapter 2: The Role of Innovation and National Innovation Systems (NIS) in Economic Development

2.1 Introduction

An extensive body of literature has deliberated and debated how interventionist policies did or did not contribute to countries' economic growth, primarily focusing on the East Asian economies. However, theoretical and/or empirical work exploring the contribution of interventionist policies in establishing innovation systems is not as extensive as those that consider economic growth. The commonly cited reason for this relative lack of analysis is the complexity involved in such a study instead of addressing *market failure* arguments, which aligns closely with neo-classical economics (Dodgson et al. 2011, 1146). The complexity and evolving nature of innovation systems make its capture of a static economic theory elusive (Dodgson et al. 2011, 1146, Edquist and Chaminade 2006, 113, Balzat 2002, 4, Edquist and Hommen 2008b). Where researchers attempt to assess the performance of innovation systems, they face the hurdle of measuring performance and obtaining data (Carlsson 2007).

A discussion on systems of innovation without referring to Chris Freeman is nearly impossible. Freeman, following on Schumpeter, viewed technological and related social innovations as reasons for dynamism and instability in the economic sense, and that technological capability is the source of competitive strength for both countries and firms (Freeman 1987, 1, Freeman 2003, Fagerberg and Srholec

2008). Following this view, one critical ingredient for Malaysia will be to have a system of innovation that promotes innovation capability, which strengthens its competitiveness to achieve higher economic development. This Chapter sets out to capture the concept, debates, and challenges surrounding National Innovation Systems. This conceptual unpacking will assist in reviewing the policies implemented by Malaysia over the years and how they contributed to building an Innovation System capable of enhancing the innovation (technological) capability. This analysis is of importance and interest, given that many of the policies implemented by the Malaysian government inspired by their East Asian counterparts yielded different outcomes.

In the coming sections of this Chapter, a discussion to demystify government intervention in building an innovation system is undertaken. The proponents of innovation systems argue that governments need to interfere not due to *market failure* but rather to a *systemic failure*. These scholars argue that an effective innovation system must exist to nurture innovation capability. If an effective innovation system exists, it will assist in bridging the gap at the catching-up phase – likewise the gap to becoming a high-income nation.

2.2 What is innovation?

What is meant by an innovation system can only be fully appreciated if the concept of innovation is understood. According to the OSLO Manual ('Manual'), which the OECD and Eurostat jointly publish, innovation is defined as follows:

> "An innovation is a new or **improved** [emphasis added] product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)" *(OECD and Eurostat 2018, 20).*

According to the Manual, innovation can signify both activity and outcome. The definition uses the generic term *unit* to describe the actors responsible for the innovations.

It further defines innovation activities as follows:

> "...include all developmental, financial and commercial activities undertaken by a firm that are intended to result in an innovation for the firm" (OECD and Eurostat 2018, 20).

It defines business innovation as follows:

> "… is a new or improved product or business process (or combination thereof) that differs significantly from the firm's previous products or business processes and that has been introduced on the market or brought into use by the firm" (OECD and Eurostat 2018, 20).

These definitions do not indicate creating a novel product or process but instead focus on a significant improvement from a previous version of the product or process.

The Manual further states that firms can only leverage innovation opportunities if the actors within the system have technological capabilities. Accordingly, the Manual defines technology broadly as "the state of knowledge on converting resources into outputs" (OECD and Eurostat 2018, 119). It stated that technological capabilities included knowledge of existing technologies and the ability to use and advance them. The latter is said to be associated with R&D activities (OECD and Eurostat 2018, 119). Three types of technological capability are essential, i.e. technical expertise, design capability, and capabilities to use digital technologies and data analysis (OECD and Eurostat 2018, 119).

Besides the definition offered by the Manual, some researchers equate innovation to knowledge. They claim that it is a continuous cumulative process of fostering new radical or incremental knowledge (Lundvall 2007a, Carlsson 2003). Given a vast opportunity set and bounded rationality, actors within the economy gain knowledge through their efforts, purchases, formal technology transfer arrangements and spillovers from others. However, the acquisition will only be possible if the actor(s) has sufficient absorptive capability (Carlsson 2003, Lundvall 2007a).

Next, it is crucial to differentiate between invention and innovation. Schumpeter first made the distinction when he referred to invention as novelty and innovation as the result of entrepreneurial activity, converting products and processes into items of commercial value (Schumpeter 1947). The latter definition requires comprehensive study, especially for a country at a catching-up stage, where it must display the ability to absorb imported or transferred technologies and convert them for market consumption (Li, Ji, and Zhang 2020, 3, Carlsson 2003, Lundvall 2007c, 101, Malerba and McKelvey 2020, 503).

Lundvall, however, interjects by stating that besides entrepreneurial activities, the process of diffusion and use should also be included in the definition (Lundvall 2007c, 101). Accordingly, the "theory of innovation diffusion" distinguishes between external and internal factors. The former considers the nature and adaptability of the technology imported, which influences the speed of diffusion – the more complex the technology, the more delayed the diffusion. Adaptability is dependent on skills, knowledge, tools, and other supporting considerations. As for the diffusion process, communication and transportation infrastructure play a pivotal role. Hence, where the institutions within the innovation system are outdated or underdeveloped, it will hamper diffusion (Li, Ji, and Zhang 2020, 3).

The internal factor refers to the nature of firms found in the recipient economy (Li, Ji, and Zhang 2020, 3). In sum, technical innovation is a cumulative and path-dependent process (Lundvall 2007c, 101). However, innovation performances are not simply dependent on R&D and other technical and marketing activities but also on the efficiency of managing these resources. Therefore, the scale of R&D does not necessarily equate to innovation; although it is a necessary condition, it may be insufficient (Freeman 1987, 18).

The common conception of innovation links to scientific innovation, i.e., fundamental and abstract forms of knowledge originating from universities or laboratories. This idea is flawed since most technological innovations result from new products and processes where most technological changes occur (Cooke and Schall 2007, 901). Although the distinction between *new* and *improved* forms of innovation is helpful, it does not explain the differences. This anomaly is deflected by referring to radical and incremental product innovation. The former refers to a significantly different product from an earlier product (radical innovation). The latter is where existing product performance has been significantly enhanced or upgraded (Cooke and Schall 2007, 901).

All these innovations take place within a system. Therefore, innovation systems are an institutional arrangement that facilitates technology transfers amongst economic actors. For this reason, the innovation systems framework requires the components of the system to be specified, the relationship amongst these components analysed, and the attributes and characteristics of the components identified (Carlsson 2003). In this thesis, the common definition of innovation is adopted. It will not focus on the difference between innovation and invention; instead, it will on whether Malaysia has acquired the capability to innovate (inclusive of inventive capability).

2.3 Innovation Systems: Defining the National System of Innovation

The innovation systems concept relates to the *general systems theory* used in natural sciences and *borrowed* by social sciences. Despite the generous usage of the idea, it lacks a precise definition (Edquist and Chaminade 2006, Lundvall 2007c). It gained prominence when arguments of accumulation of capital and labour failed to explain the East Asian successes. Scholars like Freeman [5] posit that institutional changes need to occur for capital accumulation (Freeman 2002, 192,

[5] Technological infrastructure and international competitiveness is the text that started the research on innovation. It marks Freeman's prominent role in initiating research in the area of innovation systems. Freeman was the founder of the Science Policy Research Unit (SPRU) at Sussex University, the leading school on innovation research.

Lundvall 2004, 531). Therefore, the innovation system framework facilitates the economic analysis of innovation patterns besides being a practical tool for policymaking. It is a systemic approach that presupposes that there is an interplay between various actors and institutions within the system and involves the examination of institutions and firms undertaking research and development; national science and technology policies; fiscal systems; education and training systems; labour markets; and influence of dominant firm organisation and strategies on development, diffusion and use of innovation (Balzat and Hanusch 2007, Fernandes et al. 2020, 2, Carlsson 2003, 859, Whitley 2001, Edquist and Chaminade 2006, Chaminade and Edquist 2008).

As such, innovation systems not only assist in the comprehension of the effect of innovation but also how it arises within an economic system, its implementation, and its effects on the economy and society (Carlsson 2003, 858, Schnabl 2007, 582, Foster and Metcalfe 2001, 11). These are essential considerations as it assists in introducing policies that promote innovation by fulfilling structural requirements and remedying inherent weaknesses (Raven and Walrave 2020, 2). However, the idea of components and interactions should be considered holistically and not an aggregate of its parts. These interrelationships and interactions are crucial for processes and outcomes, and they co-evolve and self-organise at the micro and macro levels (Edquist and Chaminade 2006, Lundvall 2007c, Carlsson 2003, 859).

The concept of innovation systems builds on actors knowing, and when that knowledge is economically applied, it leads to innovation. (Metcalfe 2007a). Ergo, the essential elements in the innovation process are knowledge and the ability to organise a productive activity, identify markets, and mobilise resources. Thus, innovation systems are the bridge between innovation and the market. However, the word national is included in the innovation systems concept to indicate that economic policy strategies and standard economics must concentrate at a national level (Lundvall 2007c, 100). Within the systems conception, national innovation systems and technological systems are the main concepts of innovation systems. The former concentrates on the geographical boundaries of innovation and the interplay of the various actors involved in the innovation and diffusion processes (see **Figure 5**). The latter is attuned to technology and industry, concentrating on the network of agents acting in a given industrial area within a given institutional infrastructure (Breschi and Malerba 1997, 130).

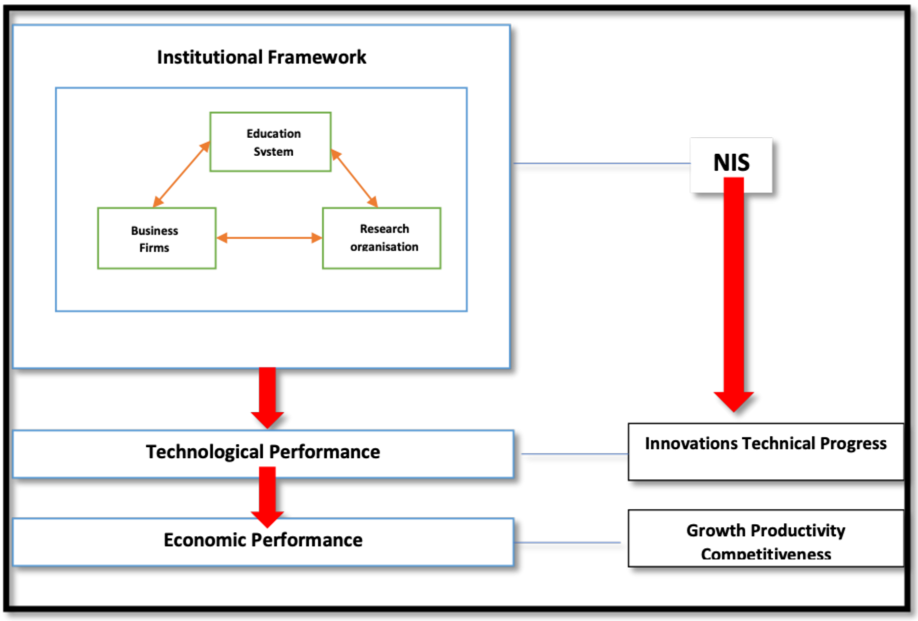

Figure 5 National Innovation system for economic success

Source: Balzat (2002, 14)

Another concept gaining popularity is regional innovation systems that focus on "innovative activities within geographic regions at the sub or supra-national level" (Carlsson 2006, 58). This concept proliferated since the mid-1990s and gained popularity due to the successes of the various regional clusters (Lundvall 2007c, 100, Asheim and Coenen 2005, 1174).

In a similar vein, the concept of sectoral systems of innovation as introduced by Breschi and Malerba (1997), where "(group) of firms active in developing and making a sector's products and in generating and utilising a sector's technologies; such a system of firms is related in two different ways: through a process of interaction and cooperation in artefact-technology development and processes of competition and selection in innovative and market activities", has garnered attention (131, Tether and Metcalfe 2003, 12). The agents are characterised by "specific learning processes, competencies, beliefs, objectives, structures and behaviours, including organisations and individuals. They interact through communication, exchange, cooperation, competition and command processes, but importantly, these interactions are shaped by institutions (such as rules and regulations)" (Tether and Metcalfe 2003, 12, Malerba 2005, 65-66).

Suffice to say that there are various other innovation systems by differing schools of thought. However, for this thesis, the national innovation system is utilised to analyse the development path of learning and innovation to understand Malaysia's trail of developing innovation capability. "If development depends on technical and organisational change induced by innovation, then innovation stems from technical and organisational knowledge" (Lundvall 2007c, 114).

2.4 Origin of National Innovation Systems

The origin of the National Innovation Systems concept can be traced back to the national systems of production as introduced by Friedrich List in 1841 (Lundvall et al. 2002, Lundvall 2016, 225, Freeman 2002, 192, Lundvall 2004, 533, Carlsson 2006, 57). List pointed out the need to build "national infrastructure" and "institutions" to promote the accumulation of "mental capital" to spur economic development (Lundvall et al. 2002, Lundvall 2016, 225, Freeman 1995, 5, Lundvall 2007a). However, List only introduced a vague concept without prescribing any analytical tools (Lundvall et al. 2002).

The concept began to shape up through the collaboration between the IKE Group in Aalborg and Christopher Freeman in the 1980s, which contributed to the earlier iterations of the idea (Lundvall 2007c, 96, Chaminade, Lundvall, and Haneef 2018). The IKE Group was inspired by the French structuralist Marxists and developmental economists who contributed through the ideas of "national productions systems" and "industrial complexes" (Lundvall 2007c, 96, Lundvall 2004, 533). These ideas claimed that vertical interaction is vital for national economic performance, which is linked to specialisation and international competitiveness (Lundvall 2007c, 96). The IKE Group version identified the main national factors which potentially influence the rate and direction of technological innovation in a country and its interaction between the key national institutions, particularly in the manner innovation is financed and governed; its competencies; and national market incentives and pressures (Tidd and Brocklehurst 1999).

However, it was not until 1987 that the idea began to crystalise. The phrase National Innovation Systems was coined by Christopher Freeman, who studied Japan's impressive economic and technological performance through the innovation system lens (Chaminade, Lundvall, and Haneef 2018, Lundvall 2016, 225, Edgington 2008, 3). Freeman was critical of neoclassical macroeconomics and stated that governments need to actively promote the technological infrastructure and not rely on free markets. Therefore, governments must be aware of existing technological systems and whether these systems can adapt their institutional set-up to new technological development, which is critical to creating an effective system of innovation (Edquist and Chaminade 2006, Chaminade and Edquist 2008, Chaminade, Lundvall, and Haneef 2018, Lundvall 2007a).

Works around national innovation systems have introduced a narrow and broad definition of national innovation systems (Freeman 2002, 194, Lundvall et al. 2009, 3). The narrow conceptualisation of innovation concentrates on institutions that promote knowledge acquisition and dissemination as the main component. The narrow sources of innovation throughout the historical period are shown in **Table 1.**

17th Century	**Academics of Science, Royal Society 1662, "Proceedings" and Journals, Internationalism of Science, Science Education**
18th Century	"Industrial revolution" (factories), Technical Education, Nationalism of Technology Consulting Engineers
19th Century	Growth of Universities, PhD and Science Faculties, Technische Hochschulen, Institutes of Technology, Government laboratories, Industrial R&D in-house, Standards Institutes
20th Century	Industrial in-house R&D in all industries, "Big Science and Technology", Research Councils, NSF, etc. Ministries of Science and Technology, Service Industries R&D, Networks

Table 1 National systems "narrow" institutions (sources of innovations)
Source: Freeman (2002, 194)

However, both the Freeman and Aalborg versions of NIS aimed to understand the innovation system broadly (Lundvall et al. 2002, Lundvall 2007a, Varblane et al.

2007, 401). The broad approach recognises that these narrow institutions are housed by a more extensive socio-economic system where political and cultural influences and economic policies help determine the success of the innovation activities (Freeman 2002, 194). Thus, the broader approach considers "social institutions, macro-economic regulation, financial systems, education and communication infrastructures and market conditions" (Lundvall et al. 2009, 3-4, Varblane et al. 2007, 401).

NIS gained momentum due to the linearity of knowledge-push innovation ideas, i.e., considering innovation processes as a sequential series concentrated on hard sciences as indicators of technical change (Whitley 2001, Balzat and Hanusch 2007). Such an approach ignores the nuanced non-linear, and context-specific manner innovation activities are undertaken. Hence an understanding of how knowledge is created becomes pertinent. In that science and technology and technical changes are separate areas of knowledge production. The latter relies on tacit knowledge acquired in the development and implementation of technological changes, making the knowledge developed to be highly contextualised and dependent on the firms' skills. This view contradicts the neo-classical theory of readily available knowledge without transfer costs (Whitley 2001, Romer 1989, 12, Woojin and Eunjung 2009, 4). In sum, a system form of thinking encourages policymakers to concentrate on the demand-side policy push, which considers innovation holistically instead of focussing on hard science and technology (supply-side policy push) (Guan and Chen 2012).

However, NIS is a new discipline; the concepts are diverse, with various interpretations of fundamental terms, assumptions, and terminological inconsistencies (Balzat and Hanusch 2007). At present, the development and performance of a NIS are determined by various co-evolutionary processes – economic, social, political, technological, and institutional. However, there is no evidence of accurate differentiation between institutions and organisations within the NIS concept.

The reality is that NIS is both complex and heterogeneous making it near impossible to emulate some aspects of a successful system and implement these with success in another less successful system (Balzat and Hanusch 2007). Further path dependence and historical uniqueness imply that innovation processes are irreversible, cumulative, and open (Woojin and Eunjung 2009, 4). Hence, if innovation processes are viewed as institutionally embedded activities, then the presumptions of historical uniqueness and path dependence will be deemed to apply to the evolution of institutional framework conditions. Moreover, if historical circumstances are supposed to have nuanced country-level features, innovation and learning activities will consequently possess deep and historically-grown national specifics as well (Balzat and Hanusch 2007). Thus, it is suggested that innovation activities are decisively shaped by nation-specific institutional framework conditions where strong interdependences exist when executing innovative activity between the different organisations and institutions.

A survey of literature on NIS categorised works in the following broad themes: analysis of NIS of identified countries with Japan being the most studied jurisdiction; policy discussions; a general description of NIS; analysis of identified industry or sector; analysis of developing or transitional economies; comparative studies; conceptual or theoretical discussions; globalisation; and other general innovation system studies (Carlsson 2007, 860-861, 2003). National Innovation system studies also focus on policies related to technology infrastructure (the supply-side consideration), promotion of R&D; intellectual property rights; and public and private research institutes (Carlsson 2003). An overall observation drawn from the sea of literature is that effort in national policy has primarily been to improve technology infrastructure, which meant increasing supply and improving the diffusion of innovation instead of focusing on the stimulation of entrepreneurship (Carlsson 2003). **Table 2** below provides a summary of critical works in NIS.

Author	Definition	Key Factors	Unit of Analysis
Lundvall (1992)	Narrow definition: organisations involved in searching and exploring Broad definition: institutional set-up affecting learning as	Institutional set-up of a specific firm, a constellation of firms, or a nation. Open and flexible relationships	R&D departments, technological institutes, and universities Production system, marketing system, and financing system

	well as searching and exploring		
Nelson (1992)	Institutions and mechanisms supporting technical innovation	Institutions that function as supporting and uncertainty-avoiding organisations	Firms, domestic market customers, education system, and government policy
Freeman (1995)	Network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies	Network of institutions Role of the state	State-level: government organisation & policy, education system, technical and scientific institutions, and cultural traditions Firm-level: company's R&D and conglomerate structure

Table 2 Key works on the national system of innovation

Source: Hee Lee and Yoo (2007, 454)

One key reason for the exponential growth of the NIS concept is the failure of macroeconomic theories in explaining 1) the success or failure of intervention policies and operations of international competitiveness and economic development and 2) the division of specialisation among policy institutions and analysts; posing a practical challenge (Lundvall et al. 2002). Hence, NIS analytical concept seeks to redress the limitations highlighted and offer a practical solution for countries – especially those in the catching-up stage (Lundvall et al. 2002).

2.5 Innovation System Assumptions

Lundvall (Lundvall 2007a), upon a review of literature on innovation systems and in an attempt to provide an innovation systems framework, identified several assumptions which provide the parameters within which the concept operates. These assumptions were:

1. A dynamic coupling exists between a country's action and the state of knowledge of the people and firms in these countries (875). This coupling suggests that both production and knowledge structure changes slowly and involve learning and industrial change (875).
2. The knowledge that is important for economic performance is localised and is not easily transferrable. In the fictitious neo-classical world, perfectly rational agents can control knowledge and have free and unlimited access. If such is the case, the NIS construct will be redundant and unnecessary (875-876). As such, the assumption is that knowledge is beyond information and includes tacit learning.
3. Essential aspects of knowledge are embodied in the "minds and bodies of agents, routines of firms, and relationships between people and organisation" (876).
4. The focus is on the "interaction and relationships" of agents. This interaction between knowledge carriers and processes is where new knowledge is created (876). This assumption presupposes that

innovation does not exist in a vacuum but rather is a product of an interactive action of firms, knowledge institutions, and people (Metcalfe 2003, 104). This notion implies that the system needs to be characterised simultaneously through its elements and relationships. Hence, it is crucial to consider the relationships when explaining how the elements change and what transpires inside them, which may reshape their relationships (876-877, Komninos and Tsamis 2008, 5).

2.6 Empirical Analyses on Systems of Innovation

Assessing the performance of innovation systems is an area that is least explored for the simple reason that it is difficult to measure and requires extensive historical data that can be detailed and complex. There is much room for work in this area, both in the qualitative and quantitative areas. Hence, it is one of the main motivations of this thesis in undertaking a longitudinal historical analysis of Malaysia's development plans to assess its innovation system.

Notably, the development of formal and tangible elements of technological infrastructure is easier to describe and analyse. However, measuring innovation is challenging. The standard measure was through R&D and University research outputs and numbers of professionally trained engineers. These measures do not capture the changes in the interaction and communication between the actors involved in an innovation exercise. These data are highly relevant to describing how the system operates as a whole (Lundvall 2007a).

Analyses in this area rely on "proxies" of innovation because the definition of the phenomenon itself is relatively "soft" (Schnabl 2007). The literature identifies a few indicators that have been historically utilised as proxies to determine the innovation process. These indicators are R&D expenditure, number of patents applied and granted, use of a license, marketing activities for new products, and patent literature citations (Schnabl 2007). However, these indicators are insufficient for innovation system analyses.

Another empirical analysis method proposed to understand innovation processes in the development and diffusion of innovation, is activities based (Edquist and Hommen 2008b). This Activities based theoretical framework developed by Edquist (2009) analyses the development and diffusion of innovation. This framework was first used to analyse the innovation systems of small countries and focused on the activities within each country's systems of innovation. The list of activities is not conclusive and may be expanded in the future. Edquist conceived ten hypothetical activities (Edquist and Hommen 2008b, Borrás and Edquist 2013, 1518). These activities were sub-divided into four broad categories "1) provision of knowledge inputs to the innovation process; 2) demand-side activities; 3) provision of constituents of the Systems of Innovation ('SI'), and 4) support services for innovating firms" (Edquist and Hommen 2008a, 16). Each category lists the sub-activities that come under it, as illustrated in **Table 3**.

Provision of knowledge inputs to the innovation process [1]	Demand Side Activities [2]	Provision of Constituents of SI [3]	Support services for innovating firms [4]
1. Provision of R&D and thus the creation of new knowledge, primarily in engineering, medicine, and natural sciences	3. Formation of new product markets	5. Creating and changing organisations needed for developing new fields of innovation. Examples include enhancing entrepreneurship to diversify existing firms; and creating new research organisations, policy agencies, and others.	8. Incubation activities such as providing access to facilities and administrative support for innovating efforts.
2. Competence building through educating and training the labour force for innovation and R&D activities	4. Articulation of quality requirements emanating from the demand side concerning new products.	6. Networking through markets and other mechanisms, including interactive learning between different organisations (potentially) involved in the	9. Financing of innovation processes and other activities that can facilitate commercialisation of knowledge and its adoption.

		innovation processes. This implies integrating new knowledge elements developed in spheres of the SI and coming from outside with elements already available in the innovating firms.	
		7. Creating and changing institutions, e.g. patent laws, tax laws, environment and safety regulations, and R&D investment routines, influence innovating organisations and innovation processes by providing incentives for and removing obstacles to innovation.	10. Provision of consultancy services relevant for innovation processes, e.g. technology transfer, commercial information, and legal advice.

Table 3 Activities Based Theoretical Framework

Source: Edquist and Hommen (2008b), Edquist (2005)

The activities based theoretical framework as an empirical tool is an attempt by Edquist to use activities to understand and explain innovation processes drawing upon the relationship between the activities and components (Edquist and Chaminade 2006, 119). He acknowledged that it was not a definitive list and based on knowledge as it stood.

The review of the empirical work suggests that there is no one satisfactory proxy/ies to measure the interactions of the actors within the innovation systems. While capturing the processes through output measures, most of the measures do not consider the problematic aspects of the systems approach, i.e., political and cultural considerations.

2.7 Innovation Process

The concept of innovation process originates from evolutionary economics, which concentrates on processes fundamental for the interactions between *innovation, technology institutions, and economic dynamics* (Malerba and McKelvey 2020, 505). Accordingly, these processes determine the economy's path *by creating variety, selection, and retaining some critical features* (Malerba and McKelvey 2020, 505). Hence, evolutionary economics emphasises co-evolutionary processes within the economic context that arises from the co-evolution of knowledge, a firm's industrial structure, and institutions (Malerba and McKelvey

2020, 506, Balzat 2002, 7). Innovation processes are defined by the number of entrants and changes in firms (Metcalfe and Ramlogan 2005, 225).

The innovation process has five attributes. First, it concerns business experimentation, which may at times be independent of product characteristics (Metcalfe 2005, 49, Saviotti and Metcalfe 1984, 144). It is an economic trial of ideas to increase profit or market strength (Metcalfe 2005, 49, Metcalfe 2003, 102). Hence, technology or innovation policy under evolutionary economics must be two-fold: "the processes which determine the range of actual innovations (variety) introduced into the economy; and the processes which alter the relative economic importance of the competing alternatives (selection)" (Metcalfe 1994, 933). However, these policy instruments are subjected to the same uncertainty regarding their effects on the innovation process (Metcalfe 2005, 50, Metcalfe 2007a). This is to say, as an example, the effectiveness of technology or innovation policies will very much depend on the quality and quantity of technical changes that occur (Saviotti and Metcalfe 1984, 149). As such, a policy must aim to 1) stimulate a variety of innovation activities and 2) ensure that feedback does not hamper the variety creating mechanisms (Metcalfe 1994, 933).

Second, new ideas and knowledge must surface (Metcalfe 2005, 50). It involves gathering varying information, and only an innovating firm can combine these into a plan for innovation and execute that plan (Metcalfe 2005, 50, Metcalfe 2007a, Sharif 2006, 761).

Third, innovative activity is embedded in the market process since it influences the outcomes of innovation and the ability to innovate. As such, when markets are inefficient and misleading, it harms the innovation process. Thus, competitive and market efficient policies are necessary elements in innovation policy (Metcalfe 2005, 50). Firms wishing to participate effectively need access to innovation information networks, which means investment (Metcalfe 2005, 51). Whilst information is a public good, and it is not necessarily free (Metcalfe 2007a). A distinction has to be drawn between tacit and codified knowledge, where the former relates to human skill and practice, which justifies the reason why knowledge is not free-flowing whilst the latter relates to knowledge in a material form that is publicly available (Metcalfe 2005, 52, Metcalfe 2007a).

Fourth, "systemic, emergent nature of group understanding leads directly to the basis of innovation systems" (Metcalfe 2005, 53). Thus, the fundamental task of innovation policy is the ability to self-manage when looked from a systems failure standpoint. Hence, the characteristics of the constituents and patterns of interconnectivity, and the drawing of boundaries becomes relevant.

Fifth, the ability to innovate is dependent on perceived opportunities, availability of "resources, incentives, and capabilities to manage the process"(Metcalfe 2005, 54). These four factors are an essential component of an effective innovation policy(Metcalfe 2005, 54, Metcalfe 2007b).

2.8 Innovation Systems and the Competitive Process

Market institutions should not be judged by the Pareto Optimality rule rather by their receptiveness in prodding innovation and adjusting to change (Metcalfe 2007b, Georghiou and Metcalfe 1998, Metcalfe 1994, 932). The central weakness of the market failure approach to innovation policy is not the lack of precision but its attempt to establish a policy perspective within the confines of the static equilibrium theory of markets and industry (Metcalfe 2007b, 1994, 932). "Without asymmetries of knowledge and the correlated uncertainties and indivisibilities, the competitive process has nothing with which to work. The quasi-public good nature of knowledge, indivisibility, increasing returns, inherent uncertainties of creative trial and error processes and imperfect property rights in knowledge are essential if market capitalism is to function" (Metcalfe 2007a, 955). They are not imperfections to be corrected by policy (Metcalfe 2007a). According to Foster and Metcalfe (2001), capitalism in equilibrium is a contradiction that can be explained through two-stage and three-stage evolution models, as illustrated in **Figure 6**. The former is an exogenous approach that involves selection and is evaluated based on its characteristics to establish fitness. In comparison, the latter is a process that recognises that innovation is a 'black-box' and will not be totally open and involve random processes and do not evolve around selection (Foster and Metcalfe 2001, 10, Marinova and Phillimore 2003, 45).

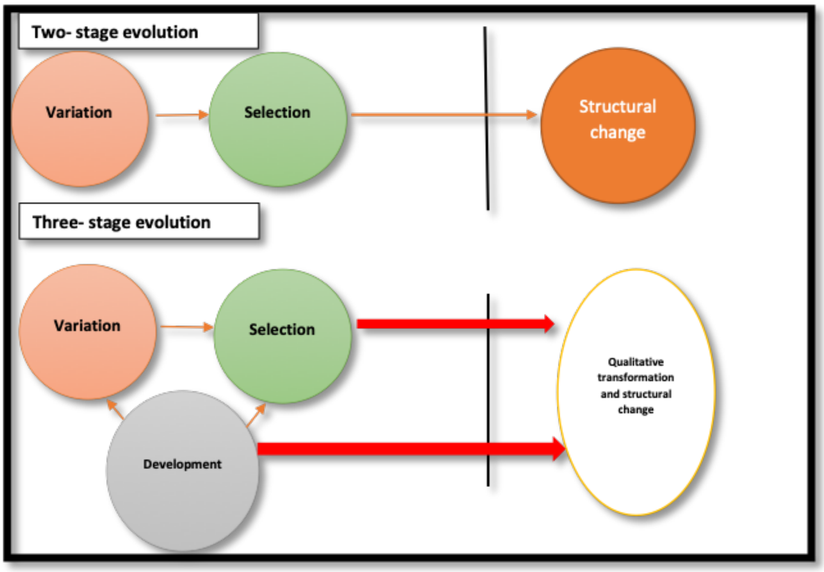

Figure 6 Models of Evolution
Source: Foster and Metcalfe (2001, 6)

This is pointing to the comparison between an existing system and an optimal one as an impossible task (Edquist and Chaminade 2006). Hence, a workable policy framework will include entrepreneurs, the reward for entrepreneurship and competition, and innovation (Metcalfe 2007a). Further, Metcalfe (1994), argued that policies need to be general, similar to 'theory' and therefore, it is vital to recognise policy failures as much as market failures (932).

As such, innovation and competition policies complement each and other. Thus, the market system provides the platform for innovation experiments and industry conversion to take place. The question that needs to be addressed will be how these competitive processes interact with the conditions that promote innovation.

2.9 Economic theories underpinning NIS

This section provides an overview of theories related to NIS. Generally, there are no specific theories to fit the concept of NIS. Although economists and scholars have made many attempts to theorise NIS, it is still a theoretically ambiguous area and relies on the evolutionary economics model (Lundvall 2007a). There is a solid push to embark on theory-based empirical research to straighten up the concept and make it more theory like (Edquist and Hommen 2008b). However, scholars like Lundvall (2007c) argue that NIS as a concept challenges standard economic theory as it deals with both macro and micro-economic aspects of innovation to explain economic growth. Given the present state of knowledge, to specify all components and relationships amongst them would be an unrealistic and mammoth task. Hence, there is no immediate need to introduce a general theory of innovation though crucial to have a clear and consistent understanding of theories to explore and hypothesise the relations between the various variables, functions, activities, and components to the development of a theory in the future (Edquist and Chaminade 2006, Edquist 2010).

Theoretically, some studies suggest innovation processes as exogenous. These proponents rigorously defined assumptions on innovation actors integrated them into formal equilibrium models and neglected to observe the organisations' characteristics in innovation activities and its main patterns (Balzat and Hanusch 2007, 926). This approach, by and large, seems to ignore the complexity involved in innovation processes of involving many actors or organisations with diverse abilities; different information on market conditions and technological opportunities; varied aims; and varied financial strength (Foster and Metcalfe 2001, 6, Lundvall 2007c, Balzat and Hanusch 2007). These complexities point to a robust interdependent relationship between the heterogeneous and learning actors and require a robust analysis to understand the complex relationships within the innovation system.

Others refer to the *endogenous 'new' growth theory in economics* when explaining innovation systems (Romer 1990, S98). This theory developed by Romer claims that technological growth should be built on "an equilibrium model of endogenous technical change in which long-run growth is driven primarily by the accumulation of knowledge by forward-looking, profit-maximising agents" (Romer 1986, 1003). This is to say that a knowledge-driven endogenous growth model provides a link between the input factors and innovation outputs, which deviates from the standard endogenous growth theory (Balzat and Hanusch 2004).

The starting point with economic theories will be from the perspective of neo-classical scholars. They have a narrow assumption that innovation processes involve only research and invention. According to neo-classical economists, innovation involves a fixed sequence of phases, where research work converts automatically into new products, which is a simplistic view. Innovation is not merely a generation of knowledge similar to information, i.e. being codified, universal, and freely available and seamlessly adaptable to a firm's specific needs (Chaminade and Edquist 2008, 3). Somewhat it is uncertain since outcomes and risks are unknown; inappropriable due to the inability of firms to appropriate the benefit of the invention arising from externalities of the research project; and indivisible due to the assumption of minimum investment in knowledge for the creation of new knowledge (Chaminade and Edquist 2008, 4). These factors lead to underinvestment in R&D by private actors from an economic and societal point of view, and this market failure requires intervention by policymakers to rectify it (Chaminade and Edquist 2008, 4). Hence, public expenditure aids by funding basic research, patent protection, and subsidisation for R&D to solve the capital market failure when the supply of finance for risky ventures are lacking (Dodgson et al. 2011, 1146).

Contrary to the assertions made by neo-classical theorists, knowledge and information are not typical economic commodities, and therefore it is not governed by markets (Metcalfe 2005, 54, Metcalfe 2007b). The central theme is that knowledge and information makers are susceptible to producing socially inefficient outcomes, which justifies public policies to correct such failures (Metcalfe 2005, 54). Thus, this narrow justification and rationale support the need for corrective innovation policy through "the joint provision of resources and incentives at the margin" (Metcalfe 2005, 54, Metcalfe 2007b). This is the potent idea for shaping policy debates. However, Metcalfe (2005), argues that this doctrine is greatly flawed through its misunderstanding of the nature and role of competition which is highly capitalistic and cannot be viewed from the perspective of equilibrium (Metcalfe 2005, 55)

The theory of a perfectly competitive allocation of resources (the doctrine of Pareto Optimality) is the fundamental underpinning of the market failure doctrine (Agresti 2000, Edquist and Chaminade 2006). "This is a distortionary mirror to reflect the operation of a restless, innovation guided capitalism" (Metcalfe 2005, 61, Metcalfe 2007a) . It is a flawed idea because it fails to realise that the concepts of capitalism and equilibrium are incompatible. When extending to innovation, the assumption is of a perfectly competitive economy (Edquist and Chaminade 2006). In theory, agents within the market system do not have the power to influence the prices of products and production aspects. A whole range of markets determines the values of all present and future economic activities (Metcalfe 2007b, Chaminade and Edquist 2008). The reverse is true, in reality. The market forces are imperfect, and those that exist do not set value for all economic activities. (Metcalfe 2007b). These factors which are not given a value in the markets they operate are known as externalities. From the standpoint of innovation, when there are compelling externalities, it leads to imperfect property rights in exploiting knowledge. The problem highlighted is the expectation of instantaneous and complete spillovers, and information on spillovers are accessible between direct competitors (Metcalfe 2007b). It is this uncertainty that may justify policy intervention.

2.10 Criteria for Innovation Policy Intervention

Policymakers could carve effective policy interventions if they understood innovation from the systemic perspective. A linear approach to innovation will send policymakers on the trajectory of correcting market failures where firms will be provided with incentives including but not limited to grants, tax cuts and intellectual property rights protections (Marinova and Phillimore 2003, 46, Dodgson et al. 2011, 1146). Whilst these may still be important, the systemic approach will lead policymakers to take stock of the broader aspects of the country's innovation system, which may impede innovation performance and support those impediments through intervention (Komninos and Tsamis 2008, 6). When "*activities, technologies, practices and firms*" (Komninos and Tsamis 2008, 6) are stopped too early or left too long, poorly coordinated, and appropriate institutions are not established, limited knowledge processing and diffusion occurs, which leads to negative lock-in and makes the transition to new paths difficult (path-dependent) (Komninos and Tsamis 2008, 6). Hence, the ability to intervene in a manner that facilitates an innovation system that is adaptive and experimental becomes imperative (Komninos and Tsamis 2008, 6). However, policymakers need to ensure that they do not “fall into the trap of imitation without analysis” (Varblane, Dyker, and Tamm 2007, 406) by continually embarking on the same trajectory or following blindly the initiatives taken in other countries without contextualising to its social capabilities (Varblane et al. 2007, 406, Varblane, Dyker, and Tamm 2007, 114).

The market failure argument positing the reason for intervention is not acceptable (Intarakumnerd and Chaminade 2007, 199). While it is not denied that markets fail and may require intervention, that is a simplistic view of the nebulous innovation system and the need for innovation policy. Thus, systems thinking allows for better policy formulation, which may be coherent and fruitful (Dodgson et al. 2011, 1146-1147). Unfortunately, policy interventions have by and large been premised on market failures.

The two conditions identified for public policy intervention in the innovation process are where there exists opportunity and ability (Edquist and Chaminade 2006). The former is a situation where private actors and market forces cannot solve a problem as it arises. The latter is where the state agencies can resolve or mitigate the problem (Edquist and Chaminade 2006). In the early days, policies were mainly Industrial policies, initiated to solve problems and this form of intervention gained appeal with the advent of the Japanese miracle in the 1970s and 1980s (Soete

2007, 275). Policymakers used regulation, a non-market mechanism mainly in the form of technical standards, subsidies for R&D by private firms, or tax incentives, to encourage economic growth (Schot and Steinmueller 2018, 1555, Edquist and Chaminade 2006). Further, operation and creation of markets were achieved through competition law and policies, and legal security and public procurement, respectively (Edquist and Chaminade 2006, Metcalfe 2003, 105, Borrás and Edquist 2013, 1516).

However, the reality of the situation is that it is impossible to determine whether public intervention can resolve the challenge. Thus, the decision of whether to intervene will depend on the likelihood of such intervention being able to mitigate the challenge at hand (Edquist and Chaminade 2006, Schröter 2009, 10). Although the decision to mitigate is based on uncertainty, the evaluation of the measure is post-implementation, which will shed light as to whether it has been successful. Policy failures in this context cannot be avoided, given the uncertainty. Nevertheless, policy objectives must be formulated before the intervention to determine the success or failure of a given policy (Edquist and Chaminade 2006). Also, policies must be developed with the realisation that the economy evolves with its challenges and problems, and hence the policy must be able to support and stimulate through these initiatives (Dodgson et al. 2011, 1153).

There are reasons forwarded as to why a public intervention may not resolve or mitigate the identified problem. On the one hand, it is forwarded that it could be due to an unsolvable problem, in which instance, neither the market mechanism and the private actors nor public intervention will be able to achieve any resolution. As for the other reason, it could be attributed to the lack of expertise on the part of the state. In which case, the state may need to acquire the skills before the problem can be addressed (Edquist and Chaminade 2006). Hence, detailed analysis and empirical comparison may be required to address the challenge. It may also involve establishing new organisations and institutions to undertake intervention activities (Edquist and Chaminade 2006). It is also crucial to note that intervention may involve situations that will occur in the foreseeable future. It is an anticipatory policy situation (Edquist and Chaminade 2006).

Policy intervention is premised on two issues, i.e. uncertainty, risk, and selectivity (Yawson 2009, 2). With uncertainty and risk – *the greater the risk, the greater the possibility for markets to underperform compared to the expectation of the government* (Edquist and Chaminade 2006, 117, Smits and Kuhlmann 2004, 8, Schröter 2009, 9). Hence, innovation policy must identify and address the factors that impede the actor in the system from performing (Dodgson et al. 2011, 1153). This could be done in two ways 1) provision of information required by the actors to develop and implement their ideas, and 2) provision of infrastructure and environment conducive for experimentation and learning (Smits and Kuhlmann

2004, 9). In the early stages, the uncertainty of demand for innovative goods may deter private actors from pursuing or investing in them. In such a situation, public institutions create markets when technology is procured, incubated, or invested in R&D activities (Schröter 2009, 10, Edquist and Chaminade 2006). Studies also indicate that large-scale and radical technological shifts are nearly impossible without public intervention, mainly where the institutional frameworks have gone into 'lock-in' (Foxon and Pearson 2008, s152).

Although uncertainty points to the need for public intervention, is government well equipped to determine which new activity should be funded instead of the private actors? This is a highly contentious area of debate amongst scholars as well as policymakers. Since innovation policy aims to resolve or mitigate a given systemic problem, there is a need to be specific and selective (Borrás and Edquist 2013, 1514). Nevertheless, the design of innovation policy, its objectives, and instruments should be based on impartial professional analyses (Edquist and Chaminade 2006). In practice, however, policies are not the result of analyses only but also political ideologies through the movement of lobbyists to favour a particular sector or industry, or imitation of existing policies that have been adopted from foreign jurisdictions without adaptation to current situations and environment (Edquist and Chaminade 2006, Borrás and Edquist 2013, 1521). Researchers argue that the basis of the selection of objectives and instruments should result from the systemic study of the system, its activities, and the division of labour between private and public actors (Edquist and Chaminade 2006, Smits and Kuhlmann 2004, 8).

Thus, the concept of market failure as a basis for policymaking is not favoured (Metcalfe 2007b). The challenge is much deeper and uncertain, involving spillovers, increasing returns, and public goods. Hence, radical uncertainty is a better justification for policy intervention (Metcalfe 2007b). Given the limits of the 'market-failure doctrine,' i.e., analysing innovation and competition through an equilibrium path is limiting. Therefore a flexible evolutionary process is a better approach for policy purposes (Metcalfe 2007b, Agresti 2000, Edquist and Chaminade 2006). Innovation growth involves multiple kinds of knowledge, i.e., how to organise and assess market opportunities.

Similarly, interventionist policy forwarded as a solution to the *market failure doctrine* reasoning is a simplistic approach to justify interventionist policies related to innovation as proponents of this *doctrine* displays a lack of understanding of innovation processes and the broader aspects of innovation and competition (Metcalfe 2007b, Edquist and Chaminade 2006). Given the focus of a system of innovation, i.e. the intricate interaction amongst the actors in the system, policymakers need to intervene where the system is not functioning well (Edquist and Chaminade 2006). Thus, the rationale of policy is based on *systemic* failure rather than a *market* failure (Edquist and Chaminade 2006)

Governments need to take responsibility for the environment of the organisations and institutions that facilitate industry R&D but recognise that without any interactions, the environment will not be deemed a system (Metcalfe 2007b, Edquist and Chaminade 2006). An alternative framework would facilitate competition. As competition thrives on innovation and innovation depends on the emergence of distributed innovation systems, this serves as an alternative to market failure perspective on innovation policy (Metcalfe 2007b). In this view, the government is not pushing the innovation agenda but is setting the environment up for innovation systems to self-organise and promote innovation activities within the economy (Edquist and Chaminade 2006, Metcalfe 2007a). However, there is no presumption that policymakers have a better understanding of market patterns or technological chances. Thus, technology policies may fail, as will technology strategies at a private firm level (Metcalfe 1994, 933). As such, policymakers also learn and adapt based on the experience of past failures since the ambit of policy is to introduce and spread technological improvements (Metcalfe 1994, 933).

Various factors have been identified in the literature about systemic failure. One of the challenges is related to the availability of infrastructure, both physical and scientific. Transition issues have also been highlighted as a potential challenge. This occurs when the firms and other actors in the system face technological issues or shifts in technological paradigms that exceed current firm capabilities. Another failure relates to the limited capability of the firm to adopt or produce new technology. This failure has some correlation to the transition problem. Technology lock-in problems are another area of failure, where the emergence and dissemination of more efficient technologies are hampered. The next area of failure relates to hard and soft institutional issues that are linked to formal and informal rules. Last are network challenges associated with linkages that are either too weak or strong within the systems of innovation (Edquist and Chaminade 2006, Chaminade, Intarakumnerd, and Sapprasert 2012, Wieczorek and Hekkert 2012).

2.11 Strengths and Weaknesses of the SI approach to Innovation Policy

The System of Innovation approach emphasises that innovation is about producing new knowledge. This is important as it regards technological change and other innovations as endogenous instead of other approaches that regard it to be exogenous (Edquist and Chaminade 2006, Balzat 2002, 15).

Further, it adopts a holistic and interdisciplinary model, focusing on all the important determinants of innovation. It also considers the historical and evolutionary perspectives, which negates the idea of optimality, as a comparison between the real and optimal systems is impossible as opposed to comparisons between real and target systems (Edquist and Chaminade 2006).

This approach acknowledges the non-linearity of innovation activities, as innovation is a complex and interdependent process. As highlighted herein, firms do not innovate independently; hence the system of innovation approach can capture this non-linearity (Edquist and Chaminade 2006). The SI approach can also encompass both product and process innovations. It also includes the role of institutions in innovation. This is an essential feature as the influence on innovation is great, though there is no consensus on the definition of an institution amongst scholars (Edquist and Chaminade 2006).

The approach, however, has a few limitations. It is conceptually vague when determining the meaning of institution, where on the one hand it refers to the various organisations and on the other, it means laws, rules, routines, and other 'rules of the game' (Edquist and Chaminade 2006). These two meanings seem to co-exist with subsequent literature working interchangeably between both the meanings (Edquist and Chaminade 2006). Another limitation is the lack of clarity on the indicators that should be included in assessing a national system of innovation. On the one hand, the literature has indicated what should be included without any indication of what should be excluded, and on the other, it advocates for an open and flexible approach. This does not give clear guidance for policymakers (Edquist and Chaminade 2006, Chaminade and Edquist 2008).

Further, the lack of theoretical backing, limits its ability to provide targeted suggestions concerning the connectivity amongst the variables. Although it could be used to formulate assumptions for empirical testing, unfortunately, work in this respect has been limited. This approach can only be labelled at best a conceptual framework rather than an established theory (Edquist and Chaminade 2006). Whilst there is a school of thought which supports this lack of theoretical backing by suggesting that it should not be *over theorised* and remain posteriori, critics argue that the concept should be built upon to make it more *theory-like* (Edquist and Chaminade 2006).

2.12 Conclusion

In this Chapter, a synopsis of the literature on NIS was undertaken. It highlighted the various theoretical underpinnings where the idea is struggling to settle and its theoretical development phase. While there are some conflicting approaches towards empirical testing, all the researchers in this area refute the applicability of the neo-classical approach in carving out policies for developing countries that aim to improve in the echelon of development like Malaysia. Hence, high reliance on market failure doctrine and perfect markets to rectify these failures will not succeed for developing countries. Understanding its innovation system and identifying its main actors, interactions, and interrelations provides a better understanding of the system's ability to innovate and provides a tool for policymakers to correct the system if it has failed to generate innovation.

Chapter 3: NIS Adoption, Implementation, and Evaluation – Innovation Success Stories

3.1 Introduction

In this chapter, a survey of three best practice countries in adopting, implementing, and evaluating innovation systems to develop innovation capability is undertaken. The countries surveyed are Sweden, the Republic of Korea and Japan since they were listed amongst the top 15 innovative countries by the Global Innovation Index 2021 (WIPO 2021). While Sweden is an aspirational comparative benchmark country, both Korea and Japan are selected since the path taken by these countries influenced Malaysian policymakers considerably over the years, particularly the former Prime Minister, Tun Dr Mahathir Mohamad. As alluded to in the previous Chapter, innovations are a result of knowledge translated into capability to create new knowledge, identify new ways to diffuse, ability to absorb technology, and ability to adapt and imitate (Johnson 2001). Therefore, a national innovation system emerges from the understanding that a country has the technological/innovation capability to be competitive, and these capabilities can be built nationally (Gupta et al. 2013b). The critical factors that will be surveyed to determine how these countries promoted innovation capability are education, technical skills, and R&D. **Table 4** captures the innovation/technology capability for the identified countries to provide a snapshot of their innovation landscape.

Country	Scientists and Engineers in R&D	R&D Expenditures as % of GDP	Business financed GERD as a % of GDP (2017)	Education Spending % of GDP (2018)	Enterprises by Business size (total) (2016)	Science Performance (PISA) (total) (2018)
Sweden	**15.13**	**3.38**	**3.27**	**1.56**	**53795**	**499**
Japan	**9.84**	**3.19**	**2.48**	**1.38**	**384781**	**529**
Korea	**15.87**	**4.64**	**2.04**	**1.56**	**n.a.**	**519**

Table 4 Indicators on Innovation/Technology Capability

Source: Compiled by the researcher from OECD (2021)

3.2 The actors established to develop innovation capability

Innovation is the result of an interactive process and is not a linear result of scientific efforts undertaken in laboratories to the exclusion of other actors within the system (Lundvall 1999). Hence various actors are involved in driving innovation, and of these actors, those responsible for developing innovation capability are of primary importance to drive the innovation agenda. The actors responsible for driving innovation through capability development for each identified country will be unpacked in the coming parts.

3.2.1 Sweden

Sweden as an industrial latecomer, began to display exponential GNP growths by 1979. It is acknowledged that Sweden has exploited technology to propel economic growth earlier in its development path. From an agricultural product exporter, it quickly moved into forestry and mining finished products, which encouraged the development of its engineering industry that modernised the Swedish economy

(Edquist and Lundvall 1993). Sweden's impressive technological growth is also attributed to the presence of large multinational corporations (MNC), where basic research and high-tech industry research took place (Romano and Zabala-Iturriagagoitia 2020, Chaminade, Zabala, and Treccani 2010, Thelen 2019, Olsson and Hallberg 2018). Most technology developments occurred in these MNCs with the support of professional government agencies (Edquist and Lundvall 1993). Hence, both the public and private sectors had a high presence of large organisations.

The Swedish Government had a strong tendency to invest in R&D, which correlates to its high innovation performance. Besides investing highly in R&D (Roos, Fernström, and Gupta 2005, Edquist and Lundvall 1993), it has balanced and comprehensive entrepreneurial and innovation systems encouraging innovative development (Romano and Zabala-Iturriagagoitia 2020).

The leading authority related to innovation development was left to the Ministry of Enterprise, Energy and Communications[6] which coordinated authorities for R&D; the Swedish Agency for Economic and Regional Growth; the Swedish Agency for Innovation System, VINNOVA; and the Swedish Institute for Growth Policy Studies, ITPS (Ramstad 2009). In 2000, the National Research Committee was established to advise the Government on research policy, chaired by the Ministry

[6] Formerly known as Ministry of Industry, Employment and Communications

of Education and Science with a mandate to coordinate the Government's research and science and technology innovation policies (Ramstad 2009). However, this Committee has since ceased operations.

The following pertinent actor is the Swedish Research Council which supported fundamental research in all scientific fields. Within this Council, there is an education committee. The Council is responsible for maintaining the quality of research and providing analyses of research and policy advice on related issues to the Government (Roos, Fernström, and Gupta 2005).

The primary actor responsible for promoting innovation is the Swedish Governmental Agency for Innovation Systems (VINNOVA), a governmental organisation responsible for designing, implementing, and evaluating innovation policies in Sweden and was established in 2001 (Eklund 2007). It finances needs-based research and development to support innovation systems. VINNOVA's primary objectives are to advise the Government on innovation policy issues, commission and conduct in-house research on innovation, and design and implement policy programmes to support and stimulate innovation (Chaminade and Edquist 2006). VINNOVA has R&D units with a high degree of competence and often collaborates with universities, research institutes and labour market organisations (Ramstad 2009). Further, it aims to promote the effective interaction of the various actors to facilitate the transformation of new knowledge into products, services and processes and ensure effective links are established (Chaminade, Zabala, and Treccani 2010).

Public technical R&D support is channelled through the Swedish National Board for Technical Development (STU), established in July 1968. This body had a mix of industrial and academic representatives to promote innovation and industrial development (Arnold et al. 2007). This organisation is responsible for responding to initiatives from firms, institutions, and others. The support obtained from STU relates to advisory, grants or loans, commissions or contracts, and fellowships for investors. Once the technology is created, other agencies will assist with commercialisation (Edquist and Lundvall 1993). The Technology Research Council (TFR) was formed in 1942 to provide research funding to Universities, particularly to the two technical universities, i.e., the Royal Institute of Technology (KTH) and Chalmers (CTH). In 1990, some of STU's roles were reduced due to the new researcher-controlled TFR. In 1991, STU merged with the state industrial development agency (SIND) and the energy agency to form Swedish Business Development Agency (NUTEK) (Arnold et al. 2007). In 1994, NUTEK's budgetary requirements were negotiated, and some transferred to a newly found Strategic Research Foundation.

NUTEK was the central public authority for economic development and provided financing for companies, regional economic development, information and advice services, networking opportunities and meeting venues, and developed clusters (Roos, Fernström, and Gupta 2005). However, it ceased operation in 2006, and the newly formed Swedish Agency for Economic and Regional Growth subsumed its role. This new organisation's agenda included promoting new and growing companies and a sustainable and competitive business sector.

The Institute for Growth Studies (ITPS) was founded in 2001, and its goal is to develop the competence of future-oriented growth policy. It analyses the economic and technical changes, evaluates political actions, and ensures quality data related to growth politics is available (Roos, Fernström, and Gupta 2005).

Research institutes, academia and private institutes are important actors in driving the innovation agenda. The research institute in Sweden evolved from the various governmental agencies and institute organisations to its present form through governmental policy reforms (Hallonsten 2017). The Research Institute of Sweden (RISE), formed in 1920, undertook a wide range of activities, including research, testing and verification, project management and coordination. It initially was a testing and verification authority until 1990, when it transformed into a government-owned company and its functions and services expanded (Hallonsten 2017).

Another actor is the Swedish National Innovation Council (NIC), created in 2015 under the Prime Minister's office. It was not a regular science or research and technology or innovation policy council, but one meant to deal with broader innovation policy matters (Edquist 2016, 2019). The establishment of the NIC is a step forward to considering innovation holistically instead of as a linear policy model.

The Swedish National Agency for Higher Education is the central agency responsible for the country's higher education institutions. It is responsible for the oversight of teaching, research, societal interaction, and knowledge transfer (Ramstad 2009). This change to higher education resulted from a parliamentary decision in 1979, where universities would undertake a significant proportion of sector-related research (Arnold et al. 2007). In the mid-1990s, the Foundation for Knowledge and Competence Development (KK Foundation) was established to address the rising concern of the relatively low qualifications in the Swedish industry and was required to build centres of excellence, build the university sector, and produce PhDs (Arnold et al. 2007). It promoted information technology, research at the higher education level and bridged the gap between academia and industry. The aim was to strengthen Sweden's competitiveness.

Sweden initially adopted a two-year vocational track co-existing with three-year academic tracks in Swedish high schools. However, these tracks were radically changed in 1991, shifting to a university studies track for all. This initiative corresponded with the increase in spending on education in the ensuing years - 5.3 percent of GDP in 1990 to 7.4 percent by 2000 (Thelen 2019). These initiatives resulted in the high completion of tertiary qualifications, surpassing the United States by 2009. Sweden's primary and secondary education system is one of the best globally, particularly science and literacy. This claim can be verified by its consistently high performance in OECD administered PISA assessments. Additionally, free access to higher education allows for inclusive growth (Olsson and Hallberg 2018).

Figure 7 depicts the research/innovation system in Sweden for capability development.

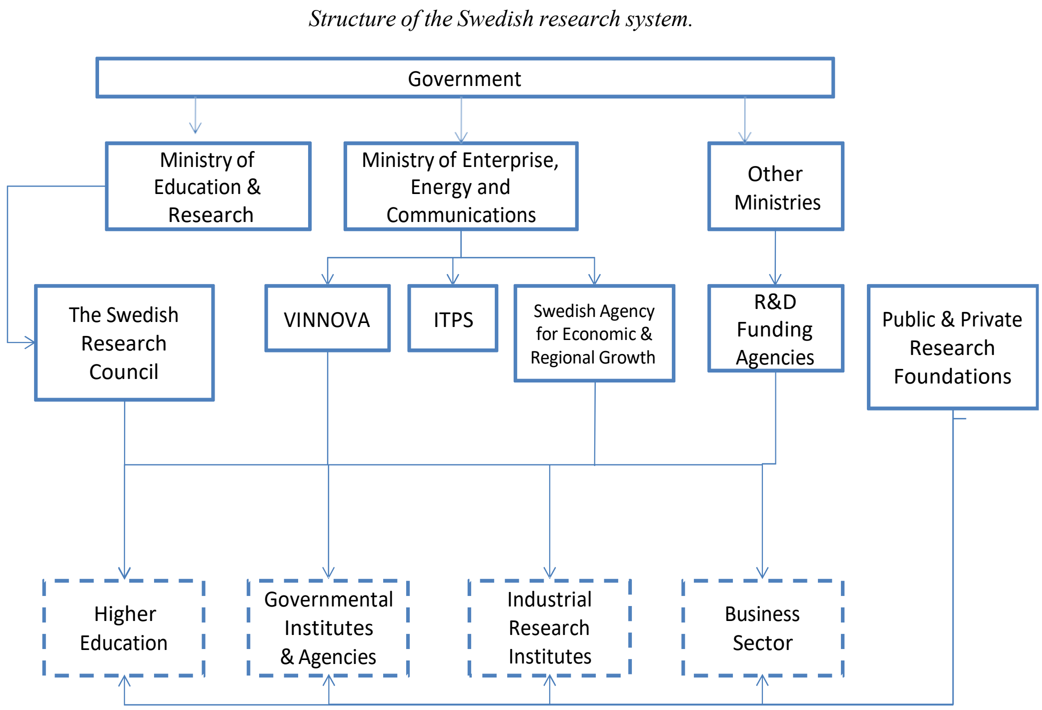

Figure 7 Structure of the Swedish Research System

Source: Roos, Fernström, and Gupta (2005) and Chaminade, Zabala, and Treccani (2010)

3.2.2 Korea

Late industrialisation allowed Korea to learn from foreign companies and reverse engineer their technologies and expertise to fit its development purpose (Henderson 1993, 208, Chang 2006, 114, Suh 2000). Using *chaebol* and five-year plans, Korea built new industries and enhanced its international competitiveness (Henderson 1993, 208, Gupta et al. 2013a, Co-operation and Development 2009). The *catch-up stage* was largely premised upon large-scale strategic development pursued through government-affiliated research institutes and *chaebol* (Keenan 2012, 16)[7] where technology capability was acquired through the interaction of foreign technology and indigenous R&D (Uttam 2012, 45). In the initial stages, the close interaction between the state and *chaebol* encouraged foreign technology's inflow through "technology contracts and licensing agreements" (Uttam 2012, 46).

Figure 8 shows the development of the Korean National Innovation system till 2015.

[7] This model is known as the Korean Model of Technological Catch-up (KMTC)

	1970s–1980s	1990s	2000s-Present
Mode	Imitative	Catch-up	Creative
Key actor	GRI	Industry	University
UIG status	University: Primarily teaching-oriented institution with weak R&D capabilities	University: Transition to research-oriented institutions	University: Strengthening of R&D capabilities with a special focus on basic research
	Industry: Minor role in the national R&D with the lack of R&D activities	Industry: Major performer in the national R&D with enhancement of indigenous R&D capabilities	Industry: Dominant position in the national R&D
	GRIs: Major performer in national R&D with absorptive and technology transfer capacities	GRIs: Strategic partner of industry with a leading role in the NRDP	GRIs: More emphasis on experimental development to produce large complex advanced technology
Policy strategies	Imitation and reverse engineering of imported technologies Building up basic S&T infrastructure for industrialization	Promotion of indigenous technology in the private sector to produce high-tech products Development of highly skilled S&T manpower and university R&D Enhancement of national R&D efficiency	Fostering innovation in industrial clusters Development of high-tech and high value-added industries Expansion of basic research capabilities Promotion of exploitation of academic research
Major policy initiatives and programmes	Establishment of the MOST to coordinate overall S&T policies and Laws Foundation of the KIST and 20 other GRIs Encouragement of vocational training in science and engineering in universities	Launch and implementation of national R&D Programme Implementation of government programmes for promoting academic research (e.g., science and engineering research center, regional research center, etc.) Reform of GRIs	Implementation of various R&D programmes for University (e.g., Brain Korea 21, creative research initiatives, connect Korea, etc.) Execution of the R&D programmes for the creation of core technology (e.g., 21st century frontier R&D)

Figure 8 Evolution of the Korean National Innovation System

Source: Yoon (2015)

The Korean Government played a leading role in guiding Korean economic growth. In 1961, the Economic Planning Board (EPB) was created by President Park and was filled by foreign-trained technocrats (Lim 2010, 197, Kim and Heo 2017, 21, He 2020, 6, Kim 2017), and was a key government agency tasked with budgeting, planning and reviewing powers of projects (Kim and Heo 2017, 21). These bureaucrats pursued economic reform, including but not limited to the alignment of exchange rates system, liberalisation of import restrictions, and magnification of export benefits (Lim 2010, 197, Hobday 1995, 32). EPB promoted economic growth using a five-year economic plan first introduced in 1962 (Kim and Heo

2017, 21). Its first business course was to shift the heavy reliance on foreign aid to becoming an independent state that supported its industry with fundamental social and economic infrastructure for its economic development (Kim and Heo 2017, 22). However, the role of the EPB gradually decreased as the government and private sector partnership gained preference (Kim and Heo 2017, 22).

In 1973, the Heavy and Chemical Industry Furtherance Committee (HCIFC) was established to spearhead economic policy decisions (Lim 2010, 196). In 1974, the Korean Government established the National Investment Fund (NIF) to fund long-term investment in Heavy and Chemical Industry (HCI) plants and equipment. The aggressive drive saw the Korean economy transform from a labour-dependent economy to a capital-dependent one (Lim 2010, 186). President Park shifted the bureaucratic powers from EPB to the Ministry of Commerce and Industry (MCI) when he actively promoted HCI. Hence, EPB did not plan nor approve any economic reforms while the HCI plan was conceived by MCI, a close ally to *chaebol* (Lim 2010, 197).

To promote the electronics and telecommunications industry, Korea established the Electronics and Telecommunications Research Institute (ETRI), a government research laboratory that had a contract with Qualcomm in the U.S. to set a technological standard in collaboration with other firms. Technological development plans are conceived and implemented in this institute. The government ministries organise government agencies to operate the research laboratories, for which they set and manage the technological agendas (Bae and Lee 2020).

To increase domestic R&D, the Korean Government initiated its first Government Research Institution (GRI) – the Korea Institute of Science and Technology (KIST), in 1966. It was the first multidisciplinary research institute and covered a range of industrial R&D. It also became the training centre for top-quality researchers and technology transfer. Nevertheless, there were poor linkages with the industry in the initial stages. In the early 1970s, the private sector started to set up formal R&D, particularly at the *chaebols*. However, the Government took steps to build technological capability in both universities and GRIs. Subsequently, a research-oriented institution specialising in science and technology was formed – Korea Institute of Advance Science (KAIS) and renamed KAIST (to include technology). This institution was different from the rest of the higher education institutions as its education system was innovative and autonomous. It went on to produce high-calibre scientists and engineers. Over time, the increased number of GRIs were inefficient, and so the Government consolidated into nine large research institutes and placed it under the Ministry of Science and Technology (MOST) to make this GRIs efficient and robust (Yim and Kim 2005). Subsequently, the Ministry of Education, Science and Technology (MEST), launched in 2008, was the combination of the former Ministry of Science and Technology (MoST) and the Ministry of Education (MOE), which took over the role. This newly formed Ministry had two branches, i.e., one dedicated to education and the other to science and technology. From 1992 to 1994, the Industry-Academy-Research Institute Cooperative Research Center (IARCRC) was established under KIST (Shapiro, So, and Woo Park 2010).

In 2013, the Korean Government established the National Science and Technology Council (NSTC), an institute responsible for the deliberation, resolution, and adjustment of national R&D. The newly formed NSTC was formerly the National Science and Technology Committee which focused more on deliberation. The new NSTC is expected to play the role of the new regulator for national science and technology(Kang et al. 2019). It is situated under the Prime Minister's office. Its primary role is to adjust major science and technology policies, deliberate human resource policies related to innovation of science, technology, and industrialisation, adjust regional technological innovation policies, and deliberate on R&D budgets. **Figure 9** provides a diagrammatic view of the government organisations involved in Korea's R&D and innovation structure.

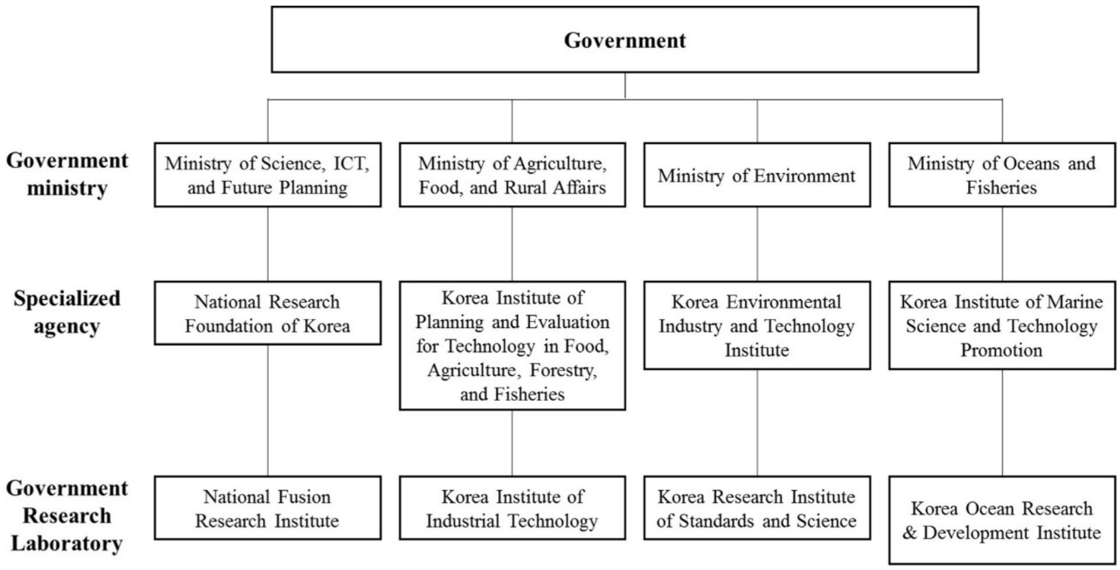

Figure 9 The R&D and Innovation Structure in Korea

Source: Kang et al. (2019)

The Presidential Advisory Council on Science and Technology (PACST) was formed in 1991 to advise the president on S&T policy and developments. Its main objectives are to develop strategic policies on technological innovation and human resource development to guide the reforms that should be undertaken to improve the innovation system. Its members are from the private sector, besides the President and the Deputy Prime Minister (Co-operation and Development 2009).

The Ministry of Knowledge Economy (MKE) was formed in 2008, which was a merger of the Ministry of Trade, Industry and Energy (MoCIE) and the Ministry of Information and Communication (MIC). It was charged, among others, to expand collaboration and trade with the international community and promote Korean exports, attract FDIs and promote Korea's energy industry. It also has implemented strategies to establish R&D networks to advance information sharing and commercialisation, streamlining research procedures and collaboration with universities, companies and institutes conducting R&D, to name a few.

The Korea Institute of Science and Technology, Evaluation and Planning (KISTEP) was established in 1999 and was reorganised with expanded functions in July 2001. In 2005, its main functions were redirected to strategic planning, coordinating, and evaluating national S&T and R&D. In 2007, it established the Korea Institute of R&DB Human Resources Development (KIRD) under its auspices. Its affiliation with the Ministry of Education, Science and Technology (MEST) was transferred to NSTC in 2011. This affiliation was further changed in 2013 to the Ministry of Science, ICT and Future Planning (MSIP)(KISTEP 2021).

3.2.3 Japan

Japan housed a political system with competent bureaucrats possessing the ability to take the initiative and operate efficiently. Its social and economic goals were pursued through the planned development process instead of market forces to allocate resources (Beeson 2009, 9, He 2020, 2, Johnson 1995a, 27). In the early days, Japan's industrial structure was dominated by *zaibatsu*, a holding company that held shares in and controlled a cross-section of industries, finances, and trading subsidiaries (Porter and Sakakibara 2004, 28, Johnson 1995b, 29). This *zaibatsu* which initially monopolised the economy subsequently was broken and re-assembled as *keiretsu*, which played a significant role in developing the

Japanese economy as it is known today (Porter and Sakakibara 2004, 29, Johnson 1995b, 30--31, Ito and Weinstein 1996, 224)

The national innovation system essentially consists of these sectors: industry, universities, and the Government. Industrial R&D is involved in the development of products and services development. In comparison, universities are focused on basic research and educating scientists and technicians. Organisational structures of corporations and industries were critical for accumulating knowledge and technological capability development (Goto 2000).

Japan holds higher learning institutions central in its innovation system and actively promoted university/industry collaboration (Goto 2000, 107) as a significant policy through the enactment of a series of legislation which included Technology Licensing Organisation Promotion Law 1998, Law to Strengthen Industrial Technological Capabilities 2000, Special Measures for Industrial Revitalisation 1999[8]And the National University Corporations Act 2004 (Motohashi 2005, 583, Fukugawa 2017, 207). The purpose was to create a dynamic innovation system and shift the domination of in-house R&D conducted by major organisations to a network of interactions amongst various innovators (Motohashi 2005, 583, 2008, 340). Japan has an excellent educational system and well-functioning training at the workplace, contributing to innovation development.

[8] Also known as the Japan-Bayh-Dole Act

The Ministry of Trade and Industry (MITI) is the bureaucratic agency that was the principal agent for collaboration between the state and private businesses, which have been archetypal of the Japanese economic system (Johnson 1982). Many have also agreed that MITI is "without a doubt the greatest concentration of brainpower in Japan" (Johnson 1982, 26, Friedman 1988, 3). MITI controlled *sangyo seisaku* (industrial policy) from conception and pursued it as a national interest (Johnson 1982, 26, Ichimura 1998, 138, Herbig and Palumbo 1996, 32, He 2020, 3). MITI's creation is deeply rooted in its political past, which will not be considered at length here. MITI's primary function was to formulate industrial policy to provide a vision for policy targets and cajole private businesses towards those lines of development (Ichimura 1998, 164, Herbig and Palumbo 1996, 33). Critics often mock MITI as being the headquarters for *Japan Incorporated*, which is far from true. It does not arbitrarily arrive at these policies but engages with businesses, consumers, and various councils and committees (Ichimura 1998, 164). Despite criticism of MITI, it is acknowledged that without MITI's influence during the economic re-construction period of identifying export industries and those with potentials and pursuing them, much of Japan's success today may not have been possible. MITI adopted some new unlikely industries as infant industries, i.e., automobiles, electronics, shipbuilding, and steel, to name a few, and promoted it successfully (Ichimura 1998, 162). As early as 1955, Japan had already adopted programs to liberalise trade and foreign exchange due to MITI's vision. In the period of rapid growth, the Committee of Industrial Structure.[9] (*Sangyo Kozo Shingikai*) ('Committee') was formed within MITI to advise on methods of developing Japanese industries. This Committee strengthened the collaboration between the Government and private organisations.

In 1999, the Technopolis program was replaced by a law that promoted new organisations' establishment and provided local municipal and prefectural governments with autonomy and responsibilities (Kitagawa 2007, 1103). By the end of the 1990s, the local cluster strategies, a complicated inter-firm and inter-organisational relationship were promoted by using Universities as the change agent (Kitagawa 2007, 1104). A total of 17 Industrial Cluster Projects were promoted by the Ministry of Economy, Trade, and Industry (METI) (the new name of the reorganised MITI in 2001) (Kitagawa 2007, 1104). A further 18 Knowledge Cluster Initiatives was promoted by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) (Kitagawa 2007, 1104).

In 2001, the Council for Science and Technology Policy (CSTP) was established, and it had broader S&T policies and projects to address with stronger decision-making powers. Additionally, S&T organisations cannot intervene in the activities of the CSTP. It is empowered to develop the overall S&T policy, including establishing S&T Basic Plan and evaluating the detailed agendas related to basic

[9] This Committee was formed in 1961

S&T policies(Kang et al. 2019). The diagrammatical representation of Japan's S&T system is as per **Figure 10.**

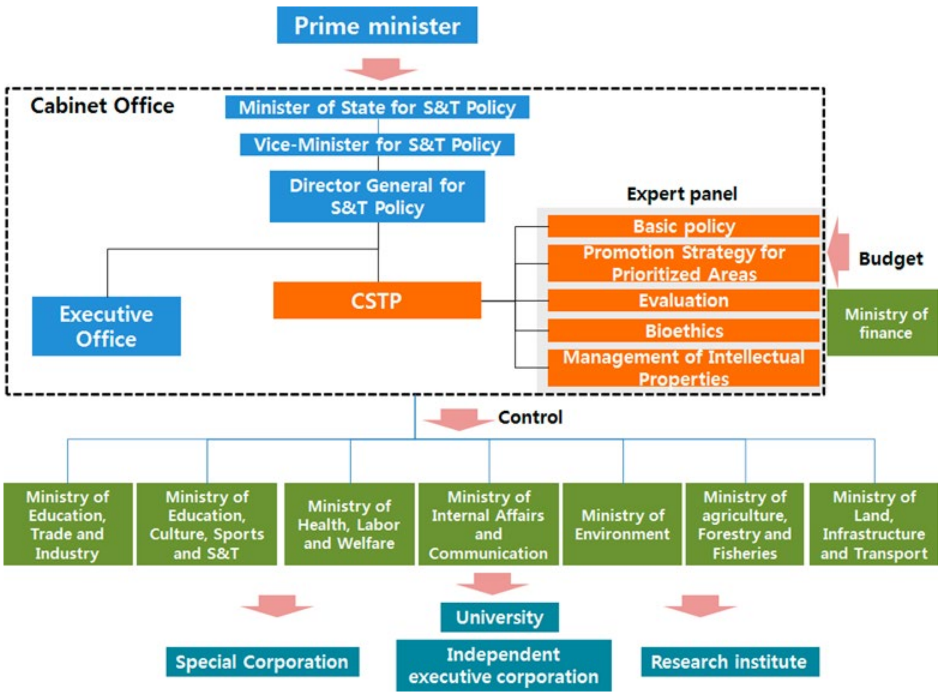

Figure 10 S&T system in Japan
Source: Kang et al. (2019)

3.3 How are actors encouraged within their NIS to develop innovation capability?

Studies indicate that firms in a strong country tend to benefit from the interactive linkages created, which increases competitiveness and economic performance (Nelson 1992). Innovation capability will depend on the availability of a university-trained workforce. This workforce is literate and numerically competent to undertake various functions outside the sphere of R&D. These people could be trained by the firms or external training programs linked to industries. Hence, it becomes pivotal to have good public education and training systems and private training to enable supply (Nelson 1992). Education-led growth has been effective in Korea, where the move to sophisticated technological innovation was made possible due to robust schooling systems. There is strong support for the proposition that solid research orientation at university and research institute levels contributes positively to innovation capability though existing studies indicate a varied result relevant to particular industries such as chemicals, engineering, and biomedical sciences (Nelson 1992).

3.3.1 Sweden

VINNOVA is the organisation that trains the innovation system developers and facilitate by providing resources needed to create efficient groups and processes for concrete results. It also provided education and training for human resources. It identified specific industries to focus on capabilities development (Chaminade and Edquist 2006).

VINNOVA funds research and stimulates co-operation between firms, universities, and policy actors in the Swedish innovation system. Its mandate included promoting a change of the academic culture, fostering entrepreneurialism and competitiveness within higher learning institutions (Trippl, Sinozic, and Lawton Smith 2015). Centres of Excellence to foster collaboration between firms and higher learning institutions.

Universities are accorded the primary role to push science innovation system. There has been considerable restructuring at the research funding system front by rechannelling the funding to revitalise the Swedish innovation system and create infrastructure to support the commercialisation of university-based research. This aim resulted in reorganising the research council sector into five large research councils – with one dedicated to basic research. Additionally, many foundations were established that did not rely on public funding but relied on the interest accrued from their respective capital bases, which are invested (Jacob, Lundqvist, and Hellsmark 2003).

As universities needed to interact with society, they were assisted by some institutions. As universities may be divergent given their academic values from the general public and lack the competence and resources to pursue engagement, a bridging institution was essential. These took the form of Technology Bridge Foundations (Teknikbrostiftelser). These organisations are diverse, and it is not the aim of this thesis to elaborate on all of them. Suffice to say that these organisations served as a bridge to overcome the limitations of universities (Jacob, Lundqvist, and Hellsmark 2003).

Swedish Government invests highly in education. Its allocation as a proportion of GDP was among the highest in the world in 2018, with 7.65 percent. Among developed nations, it came second to Norway in 2018(Worldbank 2021). A high proportion of this expenditure is allocated to tertiary education. This investment consequently leads to a high level of educational attainment. The Government highly controls the education system, but its higher education has had an internationalisation flavour since its ascension into European Union in 1995 (Bitard et al. 2008).

The actors within the innovation system are encouraged to collaborate and develop a network. These collaborations are organically developed among the actors within the system. These collaborations are found between researchers in firms and universities or institutes, resulting in joint publications or patents. According to Bitard et al. (2008), in 2003, 27 percent of all Swedish publications resulted from collaborative work between national partners and 39 percent with international partners. In specific sectors like biotechnology, the University-industry collaboration is vital and showed that 93 percent of bio-tech firms incorporated in Sweden has University collaboration. Further collaborative evidence was found in licensing, joint development, marketing or distribution, outsourcing agreements. There is evidence of strong collaboration between industry with universities, research institutes, technical consultants and suppliers (Larsson and Malmberg 1999).

The Innovative Sweden strategy was introduced in 2004 in collaboration with the Ministry of Industry, Employment and Communications, the Ministry of Education and Science, and the Ministry for Foreign Affairs aimed for a knowledge-based economy. According to Larsson and Malmberg (1999), interaction with customers and suppliers was critical for innovation capability development when it comes to technological counterparts for industries. These exist within the production systems, universities, research institutes, and competitors played a very minimal role.

Sweden also actively pursued development pairs in sectors where the state was a powerful actor and a dominant Swedish supplier. Examples of the development pairs were Televerket (state-owned telephone company) and Ericsson in telecommunications; SJ (national railways) and ASEA in railway technology; and Vattenfall (state-owned electricity generating company) and ASEA in power generation and transmission (Arnold et al. 2007). However, these were disbanded, and state procurements became competitive by the 1970s.

VINNOVA strengthened the infrastructure and investments. It built the competence centres besides investing in business incubators and providing seed capital for newly incorporated companies (Chaminade and Edquist 2006). It facilitated discussions on future growth plans by introducing the Swedish Technology Foresight (Teknik Framsy) project. Industry representatives and other relevant actors engaged in this forum in emerging technologies and critical growth areas. Besides these, VINNOVA promoted Intellectual Property Rights system changes to allow Universities to commercialise the patents generated by its researchers, which traditionally belonged to the academics per se. This development was to overcome a systemic problem of low levels of patent commercialisations.

In 2012, the Swedish Strategic Innovation Program (SIP) was launched and coordinated by VINNOVA collaboratively with the Swedish Energy Agency and the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning, where it was responsible for combining vertical and horizontal policies to achieve system-wide transformation (Grillitsch et al. 2019)

3.3.2 Korea

Korea has a well-established and successful public-private partnership (PPPs). More than one-third of government R&D funding requires collaboration between Government Research Institutes (GRIs) and private firms (Co-operation and Development 2009, Lee and Park 2006). Additionally, collaboration with universities on basic research contributes positively to increasing innovation (Lee and Park 2006).

One study discussed that one of the strategies implemented by Korea in the initial stages to jump-start its economy was the "reverse value chain" strategy (Wong 1999, 19). This strategy was pivotal in moving the latecomer firms to develop themselves to becoming fast-followers. What this means is that, for instance, if a

Korean electronics firm first started to master simple components through subcontracting or contract assembly operations which are known as Original Equipment Manufacturing (OEM), it will then acquire design skills, which will assist in the migration to Original Design Manufacturers (ODM). Finally, these firms (spearheaded by the *chaebol*) morph into developing their product ideas (Original Idea Manufacturing / OIM) and start selling this on their brand names (Own Brand Manufacturing (OBM)). A typical success story from Korea is Samsung, a leading competitor in the world consumer electronic goods market. Breakthrough is also seen in industries such as nanotechnology, where the University and Industry collaboration has yielded excellent results in increasing patents (Islam and Ozcan 2013).

Korea also pursued the Reverse Product Life Cycle Innovation Strategy (Reverse PLC), where Korean firms began by producing mature products either under technology license or through imitation (through third party consultants) (Wong 1999, 9). The initial products were backward versions of the leading versions, which subsequently assisted in the shift to making products of higher sophistication (Wong 1999, 9). However, one difference between the Korean approach and that of other developing countries was how the state disciplined the *chaebols* - poor performance was penalised and successes rewarded (Wong 1999, 19). This contest-based approach produced several high-performing *chaebols* that quickly established big-scale production, marketing, distribution, or R&D to compete globally (Wong 1999, 19).

Korea initially attempted to create closer ties between the University and industry by providing government funds to establish research centres which could be three kinds, i.e., Science Research Centres, Engineering Research Centres, and Regional Research Centres. By the late 1990s, the Government intended to promote entrepreneurship-based university research and overhauled the existing system, which allowed academics to be involved in business activities so long it did not interfere with their academic activities. Universities began to create technology transfer offices (TTOs) to handle patenting and manage technology transfer, resulting in a rapid increase in patent applications (Sohn and Kenney 2007).

Research institutions (RI) were used for diffusing the Government's technology plans to the industry. It was the primary body the supplied technology information crucial for the industry. These RIs succeeded in strengthening the ability of Korean firms' ability to absorb imported technologies (Sohn and Kenney 2007).

3.3.3. Japan

Japan focussed on building technology capabilities by promoting private R&D activities. It emphasised in-house R&D and Government-led large scale R&D

projects in selected industries to reduce the technology gap between itself and the United States of America (Park and Kim 2021).

There are certain technologies where Japan is at the frontier and holds almost 50 percent (in 2013) of the world's patents, i.e., semiconductor nanotechnology lasers. This achievement was possible due to Japanese academia receiving support from government and private organisations to focus on this type of research. The Japanese academic actors' involvement in this sector was due to significant investment and interest in fundamental research in semiconductor technology (Islam and Ozcan 2013). This form of collaboration is essential to move ahead at the innovation frontier.

Japan has a big culture of research clusters where strong linkages exist within the regions of the country. These clusters are highly collaborative and have a high international collaboration. Academic institutions have a stronger relationship (Islam and Ozcan 2013). However, recently Japan has slowed down at the innovation frontier due to its actors becoming slow to adapt due to path dependency. However, there is evidence that it still has a niche in specific industries like the game software industry (Storz 2008). Hence, on the one end, although the Japanese institutional set-up is conducive to promoting competencies, it also becomes a barrier when it involves the creation of new innovative industries.

To encourage innovation, Japan changed the laws related to inventions originating from universities. The changes allowed for commercialisation through the transfer of university inventions to the industry. These changes also recognised universities as entities and allowed them to apply for patents under domestic patent laws (Fukugawa 2016). This ability promoted close interaction with the industry where a need to identify the practicality of the invention becomes a necessity.

3.4 How do actors in these countries monitor interactions and evaluate the development of innovation capability?

It is pivotal for innovation systems to be monitored and evaluated to ensure competitiveness. If it is stuck with a path-dependency, this may halt the progress of the country. How the systems are monitored and evaluated is considered next.

3.4.1 Sweden

The interactions in the innovation system are essentially monitored and reported by VINNOVA. All projects funded by VINNOVA are evaluated periodically, and the continuation of the funding support depends on the outcome of the evaluations. The evaluation, however, is not limited to the projects per se but includes the program's performance holistically in fulfilling the innovation objectives (Chaminade and

Edquist 2006). An example of a program that has undergone significant changes due to these periodic evaluations has resulted in significant changes.

VINNOVA also oversees the progress of Higher Education Institutions (HEIs) in producing and commercialising knowledge used to benefit sustainable social development and growth. The collaboration between the HEIs and industry is difficult to be evaluated. In this case, VINNOVA assesses the performance and quality of university interactions. VINNOVA collaboratively worked with the HEIs in assessing the performance and quality of these HEIs (Wise et al. 2016, Bölling and Eriksson 2016). International benchmarking and other studies were undertaken which determined funding allocations to these HEIs. The process of evaluation is as depicted in **Figure 11**.

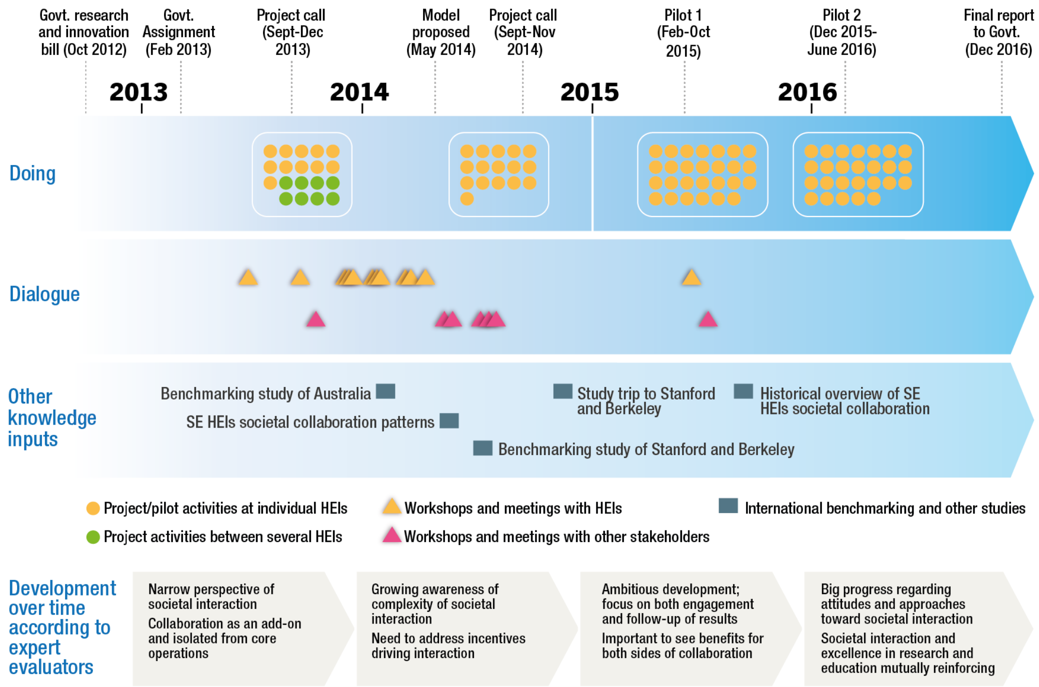

Figure 11 Process of assessing HEIs

Source: Wise et al. (2016), p8,16

VINNOVA implemented a two-step evaluating model as indicated in **Figure 12**.

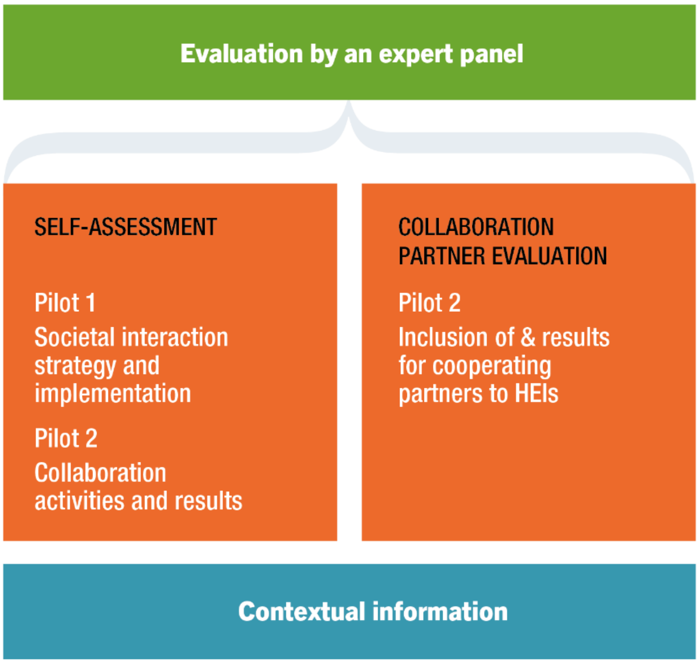

Figure 12 Model to evaluate societal interaction

Source: Wise et al. (2016), p22

Most of the programs rolled out by VINNOVA is evaluated periodically to determine whether the requirements stated by VINNOVA is complied with or otherwise. These evaluations are both a summative and formative/learning approach and focus on results achieved and strategic issues prompting future initiatives. VINNOVA focusses on the quality of implemented research and innovation/commercialisation strategies and results-based against international standards; achievement of initiatives related to organisational set-ups, process and mobility of key actors for future growth and international positioning in the respective growth areas; influence on the national innovation system; and conditions for sustainability (de Propris et al. 2015). Experts undertake these evaluations with both generalist and specialist expertise.

The evaluations undertaken by VINNOVA supports policy learning and reflections and the development of innovation systems in Sweden. It allows for improvement to existing policies to increase growth and competitiveness through innovation capability development.

Though its innovation system has good aspects, the Swedish Government has been criticised for lacking a proper governance structure for developing a robust innovation system. Although Sweden has an excellent foundation to build upon, scholars have indicated this limitation (Olsson and Hallberg 2018).

3.4.2 Korea

The Korean Government realised that proper oversight is required to eliminate unnecessary duplication and coherence of policies and programmes. This realisation prompted the large-scale overhaul where the combining of various bodies under a new body was introduced in 2008. This aim prompted the creation of the National Science and Technology Council (NSTC), which was strengthened in 2004 to rationalise and coordinate S&T activities. This formation had this Council overseeing the evaluation of the programs undertaken by the various actors within the innovation system (Rullan Rosanis et al. 2015).

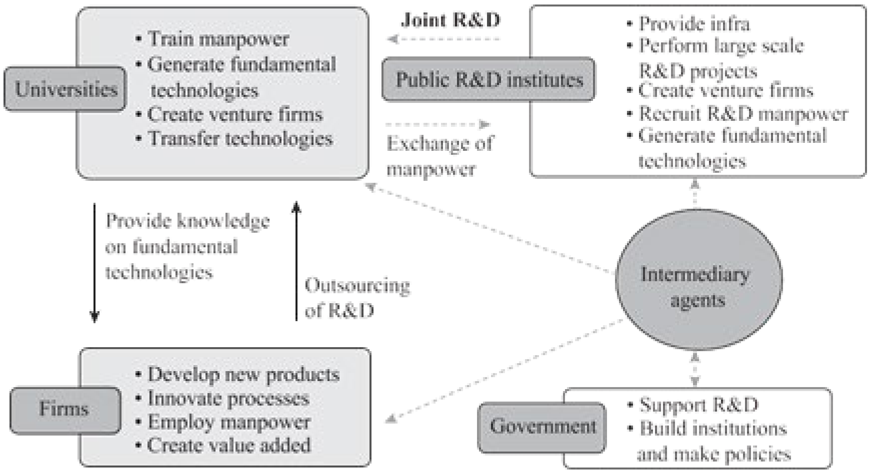

Figure 13 University-Industry Collaboration in Korea

Source: Lee (2014), p4

The innovation activities of the public sector are examined through government reports. These reports are often very detailed. Since Korea has a high number of private sector participation in the innovation system, an effective mode of monitoring and evaluation is deemed necessary. There have been scholarly debates on the need to prepare a private sector scorecard to evaluate the performance of the private sector (Ko 2019).

Through these constant monitoring and evaluation, the Korean innovation system can promote innovation capability and innovative growth. Some studies indicate its weaknesses, which is not the focus of this thesis.

3.4.3 Japan

The Ministry of Economy, Trade, and Industry (METI), one of the central bodies responsible for the innovation system, launched a Guideline for Technology Evaluation in 1997 and amended it in 2001. This guideline has been adopted by the Japanese *kosetsushi* (local public technology centres) as a basis to evaluate its program (Ruth 2006).

The Japanese Government had several public research institutes, and it has implemented the National Guidelines on the Method of Evaluation for Public R&D. This guideline provided a yardstick to evaluate public spending on R&D. This evaluation was holistic and covered every aspect starting from the policy to the evaluation of the public research institutes and the program as well. All actors need to adhere to these guidelines (Motohashi 2003).

As for education that contributes to innovation capability development, the Ministry of Education, Culture, Sports, Science and Technology Japan (MEXT), oversees the establishment of educational institutions and approves its funding. It also evaluates the performance of these institutions. However, national universities became independent of MEXT through corporatisation and had to show growth(Palmer et al. 2018).

3.5 Conclusion

The countries surveyed in this Chapter have a few striking similarities. These similarities are that large corporations propel all these economies, and the innovative push comes from the private sector. The second point worth noting is that the innovation capability is essential, and this is clearly displayed by the high reliance on university-industry collaborative effort undertaken by all these economies. Besides having established the actors and its funding mechanism, there is constant monitoring and evaluation of the system to accommodate change so that it is not stuck in a path-dependency situation. Though there is ample evidence from the literature, Japan may be a little slow in meeting the changes, but incremental changes can be surmised from the literature. This survey supports the claim made in this thesis that innovation capability measures need to establish relevant actors, establish interactive mechanisms, monitor and evaluate innovation /technological capability achievement to push the country closer to the innovation frontier.

Chapter 4: Malaysian Political Economy

4.1 Introduction

This Chapter outlines Malaysia's political development path and how that shaped economic policies and strategies leading to the development of innovation capability. This narrative reveals how a new politically independent Malaya started its regime to build a political and economic framework from a low-income resource-based country to becoming a middle-income country within 35 years. A black spot in the Malaysian political history in the form of the Sino Malay racial riots in 1969 impacted the promulgation of policies, strategies, and regulations. As a starting point, the New Economic Policy (NEP), as discussed in greater detail in the coming sections of this Chapter, became the foundation of many political actions and economic decisions. In order to appreciate the contribution of the NEP in the development of Malaysia's national innovation system and, in turn, innovation capability, it is vital to understand the heterogeneity of its population, the background to its formation as a state and the underlying socio-economic conditions. These discussions provide context, situate the study, and provide insight into policies and strategies to develop its innovation system.

4.2 Malaysian Political Evolution

Malaya, a small country with an area of 132,090 square kilometres (Hirschman 1980), was colonised by the British, incrementally from Penang Island in 1786, followed by Malacca and Singapore in 1795 and 1819, respectively (Lange 2009) [10]. By the turn of the 20th century, the Malay Peninsula was completely colonised for its strategic positioning controlling the natural trade routes of Southeast Asia. Further, being a tin and rubber producer, the raw materials for British manufacturers, presence in Malaya was a lucrative venture (Siddiqui 2012, Ken 1965, Hirschman 1989). However, these economic ventures created few backward or forward linkages to attract investments into Malaya (Hirschman 1989). Despite being the primary producer globally of these two commodities, Malaya was a low-income country as a newly independent state in 1957 (Hasan 2007, Ahmad 2008). The Federation of Malaysia formed in 1963 included Sabah, Sarawak, and Singapore[11] (Khan, Liew, and Ghazali 2014). The newly formed Malaysia faced largely rural poverty, economic disparity, and a segregated racial composition which was a daunting task for the new federal government.

At independence, Malaya's main racial composition was Malays (also referred to as *Bumiputera*), Chinese, and Indians (Siddiqui 2012). The colonial policies

[10] Malaysia was formed on September 16 1963, which comprised Malaya, Singapore, and the States of Borneo.
[11] Singapore separated from the Federation in 1965

created a situation where each racial group was associated with a specific economic activity: Chinese in trade and business; Indians in commercial crop particularly rubber plantations; and the Malays mainly in rural agriculture (Siddiqui 2012). The colonial policy kept the racial composition segregated and made it easy for the British to control trade, mining, and plantation activities (Siddiqui 2012, Ahmad 2008). Bridging this disparity became an overarching policy agenda of all subsequent Malaysian government post-independence, particularly related to ethnic Malay.

This division resulted in today's political divide in Malaysia (Rodan 2014, 827, Henderson and Phillips 2007, 83, Gomez and Jomo 1999, 10, Hirschman 1986, 331). Historians dub the Malaysian political economy "Janus-like: its ethnic aspect constantly exposed while its class aspect hidden. Thus, the structures of political economy and the inequalities they bore were susceptible to political mobilisation that seized upon real and perceived ethnic differences"(Khoo 2005, 1). Accordingly, colonial authorities recognised and promoted ethnic elites and used that premise to negotiate the Federation of Malaya in 1948 and independence in 1957 (Rodan 2014, 827, Wade 2009, 4, Majstorovic 1993, 166).

At independence, Malaya was ruled by the Alliance coalition party, formed in 1952, composed of the dominant Malay party United Malays National Organisation (UMNO); the Malayan Chinese Association (MCA); and the Malayan Indian

Congress (MIC). The Alliance adopted an ethnically representative political framework and shared powers (Rodan 2014, 827, Wade 2009, 16, Freedman 1960, 166, Ufen 2009, 605). Under the premiership of Tunku Abdul Rahman, the first Prime Minister of the independent Malaya, the Alliance coalition contested the country's first election in 1959, allocating majority parliamentary seats to UMNO. The Alliance coalition secured a two-thirds majority in Parliament, which meant the constitution could be changed at will, enabling domination by a single ethnic group by the number of parliamentary seats held.

A political milestone was achieved when Singapore and the Borneo territories under British rule joined Malaya to form the Federation of Malaysia on August 31, 1963. **Figure 14** is a political map of the Federation of Malaysia in 1963.

Figure 14 State of Malaysia
Source: The Encyclopedia of New Zealand[12]

[12] https://teara.govt.nz/en/map/34531/malaya-and-malaysia

Due to the Malay-dominated reforms pursued by the newly formed state, the leader of Singapore (Lee Kuan Yew) championed the cause of *Malaysian Malaysia* to thwart the emergence of ethnocracy (Wade 2009, 19), which resulted in the ousting of Singapore from Malaysia in 1965. With a predominantly Chinese majority, the exit of Singapore provided a further avenue for UMNO to consolidate ethnocracy in Malaysia through increased reliance on Malays in government functions and downplaying the need for English language proficiency (Wade 2009, 19).

An event that had a significant impact on future economic policies was the third general election, held in May 1969. This election saw the Alliance Party return to power with a reduced majority in Parliament and more opposition seats — whose campaign mandate was primarily premised on reduced Malay privileges (Wade 2009, 19, Stafford 1997, 556, Majstorovic 1993, 173, Gomez and Jomo 1999, 21). This result triggered an ensuing racial riot heightening the hostility between the Malays and non-Malays, mainly the Chinese[13] (Rodan 2014, 828, Bass 1971, 971, Wade 2009, 19). This riot placed Malaysia in a state of emergency from 1969 to 1971, in which period it was made illegal to discuss the abolition of Malay rights and its rulers (Wade 2009, 20). This incident was the precursor to the New

[13] Some contemporary commentators suggest that the riot was orchestrated by Tun Abdul Razak (the Deputy Prime Minister) and Harun Idris (Chief Minister of Selangor)(Wade 2009, 19)

Economic Policy (NEP) and the formation of Barisan Nasional[14] (BN), the successor to the Alliance (Rodan 2014, 828, Wade 2009, 20).

NEP resulted from an ethno-economic reassessment and was deemed an affirmative action program (Stafford 1997, 557, Gomez 2007, 6). The NEP's primary agenda push was two-fold: 1) to eradicate poverty; and 2) restructure society by abolishing the connection of a particular ethnic group to a specific economic function (Rodan 2014, 828, Stafford 1997, 557, Nathan 1995, 223, Chin and Teh 2017). The outcome of NEP was the heavy promotion of ethnic and racial-based systems of control and distribution of economic and social resources (Rodan 2014, 828). It also led to the establishment of government-owned enterprises with the sole purpose of enhancing Malay capital accumulation, which included Bank Bumiputera (M) Bhd, Perbadanan Nasional Bhd (Pernas), and Majilis Amanah Rakyat (MARA) (Gomez and Jomo 1999, 21). These developments placed Malaysia amongst the few capitalist countries to pursue NEP (and its successors) as central to its economic development plans and enforcing the ruling party hegemony (Henderson and Phillips 2007, 83). There are divided views on whether NEP succeeded in achieving its targets and, most importantly, eradicating the ethnic tensions. Some scholars argue that NEP aggravated the tension since economic considerations are but one of the fundamental issues that Malaysia faces. On the other hand, some suggest that since there has not been

[14] National Front

any serious recurrence of ethnic violence post-May 13, 1969, given the stupendous achievement of Malay corporate ownership and employment restructuring goals, NEP is anything but a failure (Stafford 1997, 557-558). One argument for the prolonged existence of NEP and its successors was that it became the card that secured Malay majority votes, thereby enabling the UMNO Malay elites to enjoy continued benefits (Gomez 2007, 6).

The policies implemented since NEP have favoured the majority ethnic group. **Figure 15** shows the ethnic composition in Malaysia for 2020. The NEP goals have resulted in complete control of the various public offices by a particular ethnic group (Wade 2009, 3). Although the Malays (the majority within the Bumiputera classification, which includes other non-Malay indigenous populations) are the majority, their presence in all these offices far exceeds their ratio within the general population. Even if a major part of this thesis does not revolve around the issue of ethnic composition, as we shall see, this preoccupation contributes significantly to the current Malaysian situation and plays a significant role in the development of the innovation system.

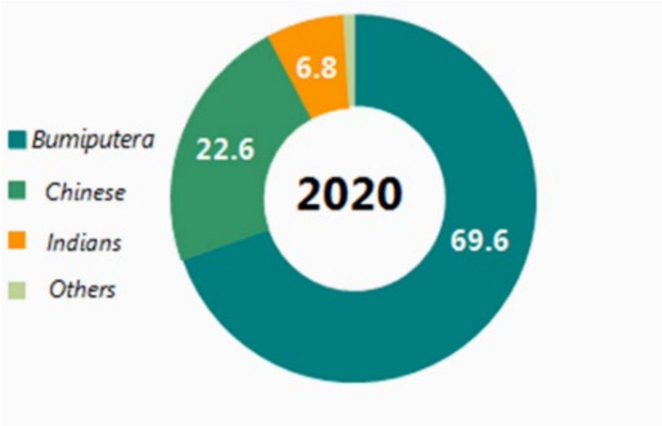

Figure 15 Percentage of Population by Ethnic Group, 2020
Source: Department of Statistics, Malaysia[15]

From independence in 1957 to 1998, BN did not have a powerful political contender since the opposition was weak and fragmented, resulting in electoral authoritarianism and a hegemonic UMNO (Ufen 2009, 606, 607, Nadzri 2018, 142). However, this changed in the mid-1990s when some parties broke away from UMNO due to a leadership crisis (Ufen 2009, 607). By 1998, the internal conflict heightened within UMNO, resulting in a movement for *Reformasi*[16] (Ufen 2009, 606). This movement was the catalyst for Barisan Alternatif (BA), an alliance of opposition parties becoming the first opposition to go against BN in the 2004 elections. Although BA's performance at the polls was dismal, it set the change motion in Malaysia (Ufen 2009, 606). In 2008, whilst the BA ironed out the differences between its composition parties, BN's main composition party, UMNO, was getting deeper in internal controversies and weaker. This situation was an

[15] https://www.dosm.gov.my/v1/index.php?r=column/cthemeByCat&cat=155&bul_id=ZjJOSnpJR21sQWVUcUp6ODRudm5JZz09&menu_id=L0pheU43NWJwRWVSZklWdzQ4TlhUUT09
[16] Reformation

opportune time for the emergence of a solid opposition in Pakatan Harapan(Ufen 2009, 606, Weiss 2013).[17] Moreover, in the 14th General Elections on May 09 2018, the BN coalition lost the elections, marking an end to an uninterrupted era of political hegemony (Juego 2018, 53, Nadzri 2018, 141). The mandate of this new opposition government was institutional reforms; anti-corruption; democracy; the rule of law; and progressive economic policies (Juego 2018, 54). However, the opposition coalition was not strong.

4.3 Malaysia: A Developmental State?

Historically, Malaysia combined a strong state and an open market economy (Juego 2018, 54). It had undeniable features of authoritarianism, where fair elections, equal rights, and civil liberties and rights have been denied (Juego 2018, 54). Economically, its open market policies are pragmatic, with neoliberal policies of privatisation, liberalisation, and deregulation being adopted (Juego 2018, 54). Its economy, embedded in an authoritarian polity, has the following similarities with the East Asian countries: (1) strong state; (2) social conflict management; and (3) engagement in a type of neoliberalism that expands the economy according to changing global climate while enriching local elites (Juego 2018, 55). Whether Malaysia is a developmental state attracts a mixed response from scholars and analysts. Some describe Malaysia as a developmental state (Dadzie 2013, Turner

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[17] Alliance of Hope

et al. 2013, Leftwich 1995, Suffian 2020). Others declare it a semi-developmental state due to its conscious planning policies with industrialisation strategies (Juego 2018, 55). However, scholars and analysts agree that Malaysia is reluctant to adopt institutions and mechanisms found in developed states due to its high rent-seeking activities and corruption (Juego 2018, 55). Political analysts view Japan and Korea as having a strong Weberian 'rational' bureaucracy, which means they are autonomous and free from vested interests. They also have a solid corporate coherence built on a concrete set of social norms forged through collaborations of communal goals, which is lacking in the Malaysian context (Juego 2018, 56).

In analysing the Malaysian development path, a comparison between the successful East Asian economies and Malaysia revealed the similarities and differences in **Table 5** below.

Ideal type 'East Asian success model'	Malaysian peculiarities
Ethnic-religious homogeneity	Ethnic-religious heterogeneity
Neo-Confucian cultural heritage	Predominantly Malay-Muslim cultural heritage; Islamic resurgence; a sizeable ethnic Chinese cultural element
Geo-strategic exposure; financial aid from the USA; propitious world markets	Limited regional importance (ASEAN); deeply entrenched in the regional division of labour ('flying geese' pattern); inheritance of a well-developed colonial infrastructure and effective administrative institutions
Socio-structural reforms such as a sweeping land reform which toppled or weakened old oligarchic and landed elites	No real land reform but FELDA[18] 'land development schemes'
Comparatively low income and wealth inequality at the outset of the catching-up industrialisation process	More marked income inequality but successful poverty reduction; rising intra-Malay inequalities through NEP trusteeship and cronyism
The relative scarcity of natural resources	The relative abundance of natural resources (e.g. tin, rubber, palm oil, mineral oil, timber)

[18] Federal Land Development Authority

Authoritarian political system; legitimacy of rule strongly based on economic performance and nationalist appeal	Formal democracy with strong authoritarian tendencies; legitimatory discourses referring to 'national unity', 'Malay unity', 'political stability' and 'growth with equity'
'Strong State' concerning state capacity and autonomy	'Strong state' about state capacity; limited state autonomy; complex embedded autonomy
Comparatively low reliance on foreign direct investments; promotions of local entrepreneurial expertise and enterprises; state subsidies and protection dependent on export performance	Heavy reliance on foreign direct investments; promotion of a 'Bumiputera Commercial and Industrial Community'
The alternation between places of import-substituting and export-oriented industrialisation	Less successful attempts at deliberate policy change and industrial upgrading enduring structural imbalances
Sound macro-economic fundamentals; high saving rates	Generally achieved; forced saving schemes such as *Employees Provident Fund*
High investments in human capital development	Education policy marred by ethnopolitics

Table 5 East Asian Model vs Malaysian Approach

Source: Trezzini (2001, 328)

Of the notable differences that require highlighting, the East Asian countries were solely economic driven with no significant consideration for other agendas. Contrary to the Malaysian position, where the affirmative agenda was interspersed with economic policies. This stark difference can be explained by the ethnic group composition, which is homogenous in these East Asian countries compared to Malaysia. Another difference worth noting is Malaysia's rich natural resources situation, which may have made it lax in pursuing industrialisation as rapidly as the other East Asian countries where natural resources were scarce and pushed to create other sources of income for economic well-being for its society. Some of these considerations will be briefly addressed in Chapter 6.

4.4 Malaysia's Economic Evolution

At independence in 1957, Malaysia was resource-based. Subsequently, it transitioned to a manufacturing and services-oriented economy (Tuah, Nadaraja, and Jaafar 2009, Wong and Goh 2012, Lean and Smyth 2014, Noh 2016, Charette 2006) with a vision of progressing towards a post-industrial knowledge-based economy by 2020 (Wong and Goh 2012, Evers 2003). This achievement was due to the active involvement of the state in economic development, inspired by East Asians tigers.

The dependence on two primary commodities, namely rubber and tin, gave way to export diversification and manufacturing via import substitution. The rationale for the shift was mainly due to the vulnerability of commodities to price fluctuations (Noh 2016, Lee and Chew-Ging 2017, 436). The shift to export diversification culminated in introducing new commodities like oil palm, pepper, cocoa, and pineapple (Ariff 1998) and subsequently oil and gas (Noh 2016).

The industrialisation stage in the 1950s shifted the focus to domestic consumer goods, resulting in saturation and raising the current account deficits (Ariff 1998, Charette 2006). The import substitution and industrialisation strategy were devised, taking heed of the International Bank for Reconstruction and Development (IBRD) recommendation in 1955. The strategy aimed to encourage local entrepreneurship through foreign capital, new tax incentives, and the provision of industrial estates and infrastructural developments (Charette 2006). In the 1960s, the economic reform plan was designed to nurture indigenous manufacturing through tariff barriers. Unfortunately, this policy failed to achieve international competitiveness as indigenous manufacturing industries exported little and could not create jobs (Charette 2006).

This inward-looking import substitution subsequently shifted to outward-looking export promotion in the 1970s (Rasiah and Shari 2001, 59) resulted in improved performance of the manufacturing sector, which grew national output and employment (Ariff 1998, Chandran Govindaraju, Krishnan Vijayaraghavan, and Pandiyan 2013b). Although Malaysia was resource-rich, resource-based manufacturing assumed a relatively low profile, i.e., 28.3% of total manufactured exports in 1996. Electrical and electronics exports accounted for 65.4% of manufactured exports (Ariff 1998).

The manufacturing industry was crucial in modernising the Malaysian economy and impetus to establishing five export-processing zones resulting in a flood of multinational corporations. In this period, Malaysia promoted the exploration, development, and production of oil resources (Noh 2016). The 1980s ushered in another bout of import substitution in the form of a heavy industrialisation program that promoted petrochemicals, iron and steel, and automobile manufacturing (Ariff 1998).

The manufacturing sector, supported by many incentive policies for potential investors, attracted Foreign Direct Investment (FDI) to Malaysia from mainly the

US, Japan, Singapore, and Western Europe (Ariff 1998). Trade flows, export destination, and source of imports were mainly to and from these countries. In 2010 South Korea and Germany joined the list of main contributors (MIDA Report).

In the initial stages of economic development, foreign investors invested in Malaysia due to its superior basic infrastructure, political stability, liberal policies, and low-wage labour market. Over time, these no longer gave Malaysia a comparative advantage when set against the other South-East Asian countries. The beginnings of globalisation and emerging markets also saw Malaysian government policies lose relevance (Xavier and Ahmad 2012). Hence, the sustainability of growth through FDI attraction from the manufacturing industry was fast eroded and hampered by its inability to acquire innovation capability (Chandran Govindaraju, Krishnan Vijayaraghavan, and Pandiyan 2013a, Tuah, Nadaraja, and Jaafar 2009, Xavier and Ahmad 2012). Due to the high reliance on FDI, the Malaysian manufacturing industry did not build its competence in becoming competitive to the extent witnessed in Korea and Taiwan (Rasiah 2011, 719).

4.4.1 Evolution of Economic and Industry Policies in Malaysia

Malaysia adopted some key economic and industrial policies to navigate its economy and innovation systems. The importance of certain key policies is evident from their continued usage through time and making it essential to be considered in-depth and hence the reason for analysing those documents as source data in the later part of this thesis.

a. *National Economic Policy ('NEP') Phase*

As discussed above, the NEP was introduced because of a racial riot in 1969. It intended to reduce inter-ethnic economic disparities through active contribution to the indigenous population and eradicate poverty (Jomo and Wee 2003, Noh 2016). This ethno-economic restructuring program was first launched in 1971 and targeted increasing ethnic Malay share in the economy by 30 percent at the end of 1990 – leading to a *just society* (Wade 2009, 24). The restructuring agenda was four-fold: 1) balance the income between various ethnic groups and regions; 2) change the landscape of employment by sector and occupation to reflect ethnic Malay participation; 3) increase equity participation in Malaysian-owned companies through 30 percent compulsory participation, and 4) increase the number of Malay business ownerships (Doraisami 2012). Since then, most public policy instruments have been dominated by inter-ethnic distributional considerations, notably the NEP (Jomo and Wee 2003). The failure of the *laissez-faire* economic framework to assuage the economic disparity between ethnic groups led to this intervention (Stafford 1997, 560).

The key drivers of NEP were the generation of wealth and "*restructuring society*" to eliminate the identification of race with economic function and location (Jomo and

Wee 2003, Doraisami 2012). One key aim was the reduction of poverty from 49 percent in 1970 to 17 percent by 1990 for all Malaysians (Doraisami 2012). Scholars observed that the NEP initially introduced as an economic measure had surpassed its inception goals to shift into education, language, culture, and religion and become the foundation of preferential treatment for ethnic Malays and other indigenous populations (Torii 1997, 209). This has led to NEP being referred to as “Malay-first Policy” (Torii 1997, 210).

In trying to achieve NEP goals, the government introduced legislation, guidelines, and several public enterprises, which inevitably led to increased intervention by the government. This approach called for policy reforms when Malaysia went through a bad recession in the early 1980s due to commodity price shocks which contracted the Malaysian economy by 1% in 1985 (Noh 2016, Doraisami 2012). With the growth of only 1.2% and an unemployment rate of 8.1% in 1986, the redistributive character and relevance of NEP were questioned (Noh 2016). To restore economic vibrance, the 30 percent Bumiputera (Malay) equity holding requirement in small Malaysian firms and foreign firms were removed. However, the foreign firms' waiver was conditional on exporting their output through the newly established Free Trade Zones (FTZs) (Noh 2016, Rasiah and Shari 2001, 58). These changes increased the presence of foreign firms in Malaysia. While the weaknesses of the NEP motivated subsequent policies such as the New Economic Model, Economic Transformation Program under the Tenth Malaysia Plan in 2009, there was still a lack of genuine political will to change the underlying Bumiputera policy. Some argue that this reluctance is causing Malaysia to remain in the middle-income trap (Schuman 2016, Lean and Smyth 2014).

b. Industrial Master Plans

The first Industrial Master Plan (IMP), heavily influenced by the Korean model of industrial development of "picking winners", was introduced in 1985 (Ariff 1998, Rasiah and Shari 2001, 66). The IMP economic structural changes resulted in the heavy industrialisation program in the late 1980s (Noh 2016, Ariff 1998, Doraisami 2012). The driver of the industrialisation program was the then newly formed Heavy Industries Corporation of Malaysia (HICOM) which managed foreign funds to spearhead the industrialisation drive (Ariff 1998, Noh 2016). As a result, automobile manufacture, steel manufacturing, cement, machinery and equipment, and petrochemical industries were established (Noh 2016, Doraisami 2012). However, these industries were straddled with high production costs, heavy debts, market glut, and excess capacity leading to poor performance standards, making them uncompetitive (Rasiah and Shari 2001, 65). These industries were sustained due to state patronage and heavy protection (Ariff 1998). Although these industries' performance was dismal, it made the Malaysian economy deeper and broader (Noh 2016).

c. The National Development Policy

Following the partial economic liberalisation after the 1985-1986 economic recession, a shift to a new broad national project was made. This shift is dubbed as "*Vision 2020*" and became the successor to the NEP by taking the avatar of National Development Policy associated with the Second Outline Perspective Plan (1991-2000) and the National Vision Policy associated with the Third Outline Perspective Plan (2001-2010) (Chin and Teh 2017, 348, Jomo and Wee 2003, Wade 2009, 24). The re-distribution agenda continued but emphasised growth, industrialisation, modernisation, and the private sector (Chin and Teh 2017, 348).

d. State Enterprise Privatisation Phase

The late 1980s was when Malaysia privatised its state enterprises in response to the Asian financial crises and Malaysia's policy stance to attract non-debt-creating finance (Noh 2016, Gomez and Jomo 1999, 75, Doraisami 2012). Since public enterprises were the main instrument of direct government involvement in the economy in the 1970s and 1980s, the Malaysian government reversed its policy due to the worsened economic conditions and budgetary requirements and privatised these enterprises (Ariff 1998, Doraisami 2012). Hence, by the early 1990s, most state-owned enterprises, including telecommunications, broadcasting, aviation, and utilities, were privatised with a market capitalisation of RM201 billion in the Kuala Lumpur Stock Exchange (KLSE) (Noh 2016, Doraisami 2012). Despite the privatisation, the ethnic restructuring agenda prevailed whereby former state managers and senior bureaucrats were absorbed into the private sector (Doraisami 2012). Further, according to Doraisami (2012), the depth of Malaysia's privatisation program was questionable since the state only relinquished 50 percent of its ownership stake and retained control through quasi-state entities (Doraisami 2012).

e. The New Economic Model ('NEM')

Responding to the urgent need to stop declining inflows and stopping outflows of FDIs (Xavier and Ahmad 2012), the NEM was introduced. It was reported that in 2009 Malaysia was one of the countries in the ASEAN region to have recorded the lowest amount of FDI inflows. **Figure 16** provides a snapshot of FDI inflows from 1970 to 2019. There was a significant increase from the late 80s till the end 90s. Thereafter, the inflow as a percentage of GDP has been somewhat constant and on a declining trend.

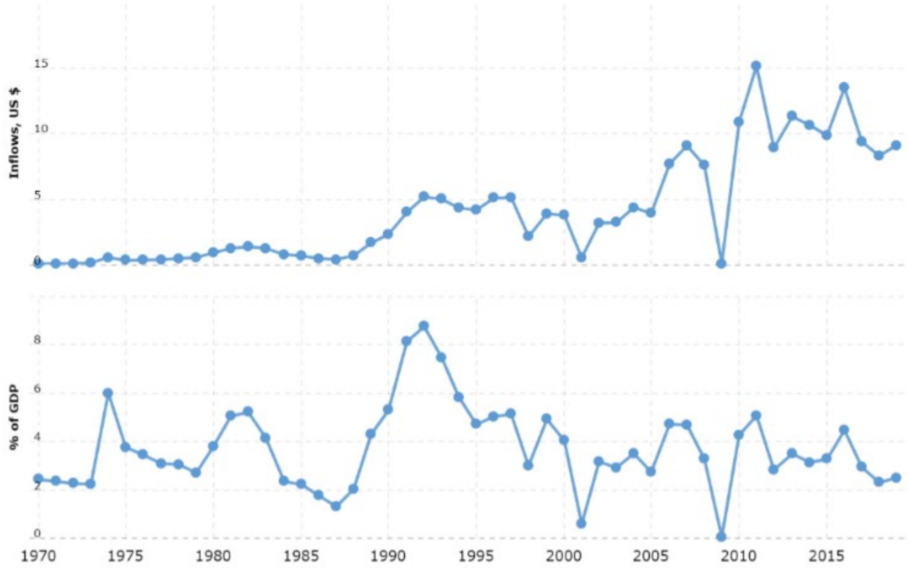

Figure 16 FDI Inflows for Malaysia from 1970 – 2019

Source: World Bank[19]

In 2010, given the economic trend, the New Economic Model (NEM) was introduced, aiming at strategic reforms to meet the goals of Vision 2020(NEAC 2010). The primary objectives were to implement radical changes to become a high-income country by 2020. The NEM aimed to achieve the goals by implementing the Economic Transformation Programme (ETP) by pursuing eight strategic reform initiatives (SRIs) (NEAC 2010). Its three primary objectives are to achieve a USD15,000 to USD20,000 per capita income by 2020, introduce inclusiveness, so all communities have a share of the country's wealth, and achieve sustainable growth. The government planned to re-energise the private sector, develop the quality of the workforce, and reduce the dependence on foreign workers

[19] www.macrotrends.net/countries/MYS/malaysia/foreign-direct-investment'>Malaysia Foreign Direct Investment 1970-2021. www.macrotrends.net. Retrieved 2021-10-04.

to achieve its goals. The primary aim was to create a competitive domestic economy, strengthen the public sector, and introduce a transparent and market-friendly affirmative action program (Lean and Smyth 2014, Rosdi and Chew 2014, Xavier and Ahmad 2012, NEAC 2010). Relevant parts of the NEM will be discussed in the analysis section of this thesis.

f. The Malaysia Plans

Malaysia has had eleven five-year development plans since 1966. These plans contain the goals, aims, and strategies for economic development (Lee and Chew-Ging 2017, 438). These development plans have structurally changed the economy and Malaysian society (Lee and Chew-Ging 2017, 437). Development planning is undertaken by a state when resources are scarce, and there is a need to mobilise the available resources efficiently to achieve its economic goals (Lee and Chew-Ging 2017, 438). A key data source for this thesis is the development plans, and a detailed analysis of the relevant parts of the Development Plans is undertaken in the ensuing Chapters.

4.5 Malaysia's Innovation Environment

Malaysia's innovation capability assessed through the patent applications and grants lens revealed a low number of patent applications and grants applied by Malaysians. **Table 6** exhibits the resident and non-resident applications and grants of patents in Malaysia, where the non-resident applications far supersede the resident application. At the outset, it provides a snippet of the innovation capability of residents. Govindaraju and Wong (2011) offered a plausible reason for these low application numbers: the lack of local entrepreneur awareness on the significance of patents and the value of proprietary interests to businesses, resulting in lower numbers of local businesses engaged in R&D activities. However, this argument is suspect given that other factors contribute to lower numbers – predominantly the ability to innovate. Although it is undeniable that local businesses' reluctance to engage in R&D may be a contributing factor, it may not be vital. However, the authors warned about drawing such conclusions, acknowledging the limitations of measuring innovation or innovation capability through patent data.

Year	Resident	Non-Resident	Abroad
2009	270	3,198	228
2010	200	1,960	317
2011	310	2,043	283
2012	295	2,165	365
2013	288	2,372	432
2014	344	2,361	512
2015	344	2,533	569
2016	355	2,969	585
2017	437	4,626	512
2018	469	3,818	516

Table 6 Malaysian Patent Applications

Source: Patent Applications, WIPO[20]

This trend on patent applications needs to be holistically evaluated by scrutinising the policies and strategies implemented by the Malaysian government to encourage

[20] https://www.wipo.int/ipstats/en/statistics/country_profile/profile.jsp?code=MY (accessed on May 11 2020)

R&D activities to determine the development of innovation capability - improving patenting output. The initiatives, institutions, and implementation strategies to encourage R&D and patenting in Malaysia are relevant to triangulate the finding by Govindaraju and Wong (2011).

Contrary to the patent applications data, the Global Innovation Index (GII) report ranked Malaysia at 33[21] out of 138 countries with an innovation score of 42.42, whilst Korea is ranked at 10 with a score of 56.11 (Cornell University 2020). **Table 7** provides the granular analysis of the various pillars analysed for Korea and Malaysia to elucidate the disparity. This comparison, however, is aspirational and not comparable, given that both Malaysia and Korea are at different levels of economic development.

Country	Economy Overall GII rank	Institutions	Human Capital & Research	Infrastructure	Market Sophistication	Business Sophistication	Knowledge & Technology Outputs	Creative Outputs
Korea	**10**	**29**	**1**	**14**	**11**	**7**	**11**	**14**
Malaysia	**33**	**40**	**29**	**48**	**20**	**31**	**38**	**35**

Table 7 GII 2020 rankings overall and by pillar for Korea and Malaysia

Source: Cornell University (2020)

Malaysia fared reasonably for the quality of universities, scientific publications, and patent indicators of innovation quality. As indicated by **Table 7**, its deficient pillars are institutions, infrastructure, knowledge and technology, and creative outputs. Although this report places Malaysia favourably for innovation outputs, it does not indicate indigenous innovation capability as the data does not distinguish the origin

[21] The 2021 report indicates that Malaysia has slipped to 36 - https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2021.pdf (accessed December 10 2021).

of the output to Malaysian ownership or residency status. Interestingly, the report highlighted that Malaysia produced many graduates in science and engineering and had high ranking universities within the region, but still ranked poorly for intangible assets (intellectual property outputs). This outcome is curious as there is no correlation between producing a high number of science and engineering graduates and intellectual output. This gap needs to be addressed, and it may be answered by determining the path dependency of policies and strategies related to education and training, organisations and regulatory frameworks, and R&D, factors crucial to building and diffusing innovation capability(Mathews and Hu 2007, Mathews 2001, 1999, Furman, Porter, and Stern 2002, Hu and Mathews 2008).

On the contribution of education to economic development, research suggests a positive correlation between promoting and creating appropriate education and institutions and economic growth (Cherif and Hasanov 2015b, Suehiro 2019). Therefore, educational measures are critical contributors to building and diffusing innovation capability (Crosling, Nair, and Vaithilingam 2015). Appreciating its importance to the economy, the Malaysian government spends about 6 percent of its Gross Domestic Product (GDP) on education, making it the highest in the South East Asian region (Jaaffar, Abd Rani, and Zakaria 2021, Fleming and Søborg 2014b). Such high investments have increased Malaysia's literacy levels, as indicated by UNESCO's Education Index (EI). The EI is calculated by taking the average mean years of adult schooling and expected years of children schooling, which is reflected as an index (UNESCO 2019). However, when a comparative analysis of literacy development in Malaysia and Korea between 1990 and 2019 (**Figure 17**) was undertaken, it was evident that Malaysia had a significant lag. It is important to note that high-literacy rates or educational excellence do not necessarily correlate with innovation unless the educational institutions established were embedded with an innovative culture (Fleming and Søborg 2014b), as was the situation with the economies discussed in Chapter 3, where such culture was embedded through a system of innovation which linked educational institutions with industry.

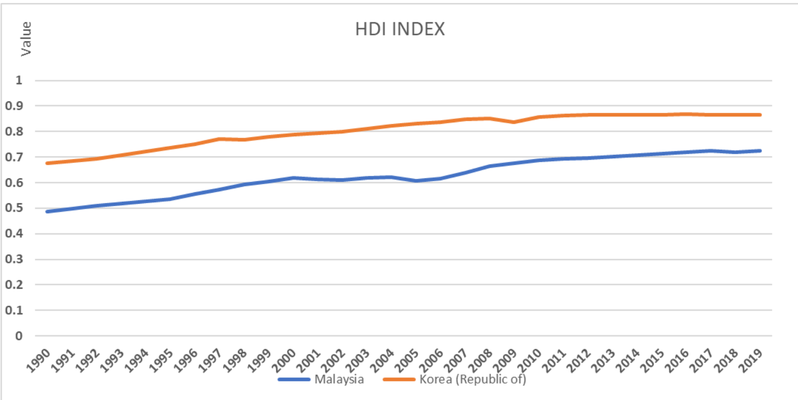

Figure 17 Education Index Comparison for Malaysia and Korea between 1990 and 2019

Source: UNESCO (2019)

Next, the shortage of technically qualified graduates impacts economic growth and productivity as a high level of skills allows countries to achieve high levels of output and productivity. (Hendrick-Wong 2020, Mustapha 2017, Doner and Schneider 2020, Espinoza and Vandeweyer 2019). Despite the number of initiatives undertaken by the Malaysian government, which will be elaborately discussed in later chapters, the outcome is still dismal. In 2019, an OECD report indicated that Malaysia faced a substantial labour market imbalance with shortages in many occupations and skills. These shortages were across medium and high skilled occupations. **Figure 18** provides a snapshot of the skill levels for Malaysia and Korea between 2003 and 2014. This comparison highlights the deficient skills situation in Malaysia.

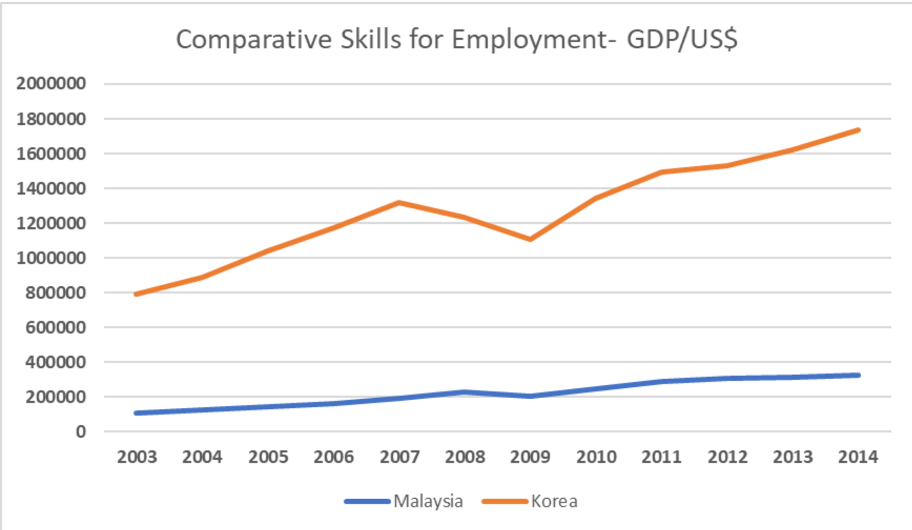

Figure 18 Comparative Skills for Employment, 2003-2014
Source: OECD Stats[22]

The inability of education and its institutions to develop innovation capability further supports the claim that the Malaysian labour cannot leverage the technology/knowledge spillover in its current state (Schuman 2010, Nallari et al. 2011). Consequently, this inability affects innovation and productivity. A country such as Malaysia must achieve high productivity levels to be at par with the other high-income countries (Revilla 2018). As an illustration, **Figure 19** provides a summary of labour productivity[23] per hour for Malaysia and Korea from 1970 to

[22] https://stats.oecd.org/Index.aspx?DataSetCode=WSDB#)accessed on September 14 2021)
[23] the labour productivity per hour is measured as GDP per hour of work

2017. From the late 80s, it is evident that Korea's productivity levels surpassed Malaysia's and, as of 2017, stands at $34.06 and $21.68, respectively. A considerable gap exists between these productivity levels.

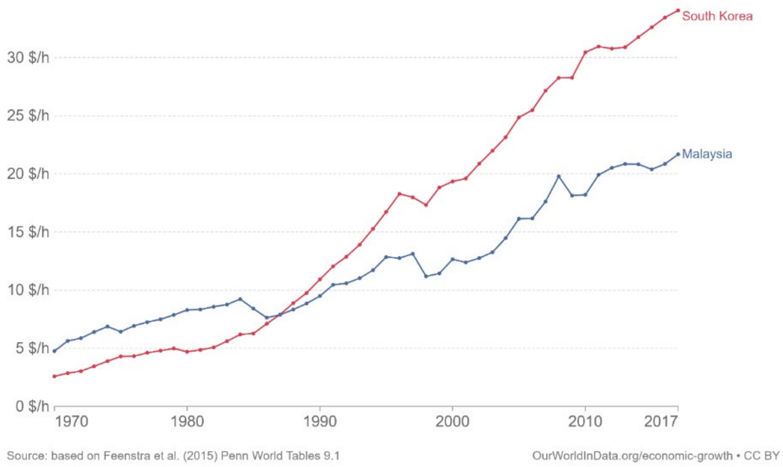

Figure 19 Comparative Productivity Level of Malaysia and Korea from 1970 to 2017
Source: OECD Stats

4.6 Conclusion

The preceding discussions reveal that the NEP, an ethno-economic restructuring program, played and is still playing a pivotal role in economic policies, including innovation capability policies and strategies. Although the focus of this thesis is not ethnic re-distribution considerations, this policy may offer the key for the various lock-ins that may exist within the innovation system, which is the core exploration of this thesis.

Chapter 5: A Conceptual Framework to Evaluate Malaysia's National Innovation System

5.1 Introduction

Qualitative analyses of national innovation systems have been undertaken by Freeman, Lundvall, and Nelson (Chaminade, Lundvall, and Haneef 2018, 41) and others. Although they have used "descriptive statistics" (42), they aimed to provide a general understanding of the policy approaches associated with economic performance through the factors of history, culture and politics. This thesis takes a similar approach in assessing the policies and strategies implemented by the Malaysian policymakers from 1965 to 2016 to develop innovation/technological capability in Malaysia. Such longitudinal study assists in interpreting the economic history path undertaken by policymakers to explain its economic situation. Narrative studies provide rich empirical insight beyond statistical analysis to understand the interaction of actors within the national innovation system and its failures (if any).

The study of National Innovation Systems is still fluid and growing. One of the analytical difficulties of NIS as a concept is data availability and reliability. Given that a system of innovation is dynamic, no one measure could adequately assess innovation. Empirical analysis often has difficulty analysing the data to draw meaningful inferences to guide countries in the catch-up stage. Frequently, researchers have used input factors such as resident patent applications; gross expenditure on R&D (GERD); business expenditure on

R&D (BERD); or the number of scientific personnel; However, it is empirically challenging to analyse interactions between actors within the innovation system, as identification of satisfactory proxies to represent these interactions has proven difficult (see Chapter 2). As a result, functional analysis of the innovation system through analytical frameworks was introduced. Edquist proposed the activities-based framework (Edquist and Hommen 2008a), extensively discussed in Chapter 2. This framework, however, is far from complete. It is an indicative framework that the researcher himself acknowledges may change in the foreseeable future, given the fluidity of this field of study. Others such as Galli and Teubal (1997), Johnson (2001), Liu and White (2001), Hekkert et al. (2007), and Bergek et al. (2008) (Chaminade, Lundvall, and Haneef 2018, 50-51) have identified other factors in their frameworks.

In this thesis, economic, historical tracing is limited to evaluating the situation with innovation/technological capability development. It will not explore all other aspects (functions) of innovation systems. The primary data source is the indicative Malaysia development plans first introduced in 1965, Malaysia Plan 1. The Malaysian policymakers used these plans to promote economic development. The policies and strategies developed, their implementation, evaluation, and correction are critical to understanding the current innovation/technological capability state. As explained in Chapter 2, using the National Innovation System lens, when the country cannot get all the inter-dependent actors to work holistically, a systemic failure exists and, if left uncorrected, will become a *lock-in* that potentially hampers technological/innovation advancement. When national governments' development paths create a situation of innovation system *lock-in,* it becomes challenging to adopt changes as the development agenda progresses. In this longitudinal study, a detailed analysis of identified factors is undertaken to explain whether such *lock-ins* existed, preventing Malaysia's innovation capability development. As indicated in Chapter 1, the factors of science, research, innovation, and skills are analysed. A detailed discussion of what these factors cover is discussed in the conceptual framework section of this Chapter.

5.2 Qualitative Study

5.2.1 Historically Grounded Analysis

Historical analysis is a method of studying records, documents, and other textual materials to understand what transpired in a given period. This analysis method requires a researcher to use various historical data ranging from texts, reports, articles, policy documents and other related periodicals (Wyche, Sengers, and Grinter 2006). It is a method that historians usually use to understand social phenomena (Wyche, Sengers, and Grinter 2006, 38). However, historical analysis is not only concerned with the past. It depends on the nature of the data collected and its use for making the difference in this form of analysis (Griffin 1992). Development studies often ignore this historical analysis as it is constantly forward-looking, neglecting the past. However, there are ample benefits gained by revisiting history as it will provide abundant avenues for correcting development policies that may have gone awry (Nilsson and Sörlin 2017). Historical narratives often bring a pattern from within an opaque system to the fore. These patterns can be investigated to improve the system. However, such a narrative needs to be used carefully, considering its source relevance and robustness (Nilsson and Sörlin 2017). Historical analysis is part of the grounded theory analysis introduced by Glasser and Strauss in 1967 that provided a method to systematically collect and analyse data in qualitative research (Bitsch 2005, 77).

Historians and sociologists of science and technology often refer to the critical role played by "social, cultural, economic and political factors" when considering the "development, deployment, and dissemination of technologies and technological systems (this can be interchangeably used with innovation) (Boyd and Holton 2018, 338). It is undeniable that all these factors affect the innovation/technological systems and merits consideration when analysing data on innovation systems. It is postulated that such historical analysis would reveal path dependence leading to lock-ins. Often innovation changes are path-dependent when policymakers insist on a specific approach based on historical events that dramatically influence the intended future achievements but do not achieve the expected outcome (Ruttan 1997).

5.2.2 Longitudinal Policy Analysis

Evaluating policies to infer policy impact is not uncommon in policy research, and it extends to an array of disciplines, particularly in biomedical sciences (French and Heagerty 2008). Qualitative longitudinal analysis plays a critical role in developing informed policy and practice (Banati and Oyugi 2019, Miller and Friesen 1982). It offers an opportunity to evaluate data over a period to trace continuity and change and provide an accurate depiction of the state of affairs as they stand (Vitale and Meijerink 2021, Lewis 2007, Corden and Millar 2007a, Rajulton 2001). This form of evaluative research intends to evaluate implemented policies and determine whether it has achieved their objective – primarily to determine their efficacy. Hence, this approach is situated within the "realistic evaluation model and emphasises on what works and also how and why policies work and their contexts" (Lewis 2007, 545). Utilising this analysis method allows for evaluating various aspects of change or variables and the relationship between them over a period and is appropriate for the current study, mainly to understand the interactions between the different actors. Such a study involves collating data over a period, and there has not been any rule established on the length of the period (Corden and Millar 2007b, Rajulton 2001). Many qualitative studies have used the longitudinal method to assess the data, but this method aims to explore "developmental or causal relationships" (Corden and Millar 2007b, 585). It embodies three requirements: 1) a research question on determining developmental relationships; 2) a sample data which ranges over a period, and 3) analysis of change over time to establish interactions (Corden and Millar 2007b, 585). Qualitative longitudinal analysis can be designed in various ways. Amongst those that have been indicated in the literature is 1) study is designed to be broadly focused and does not involve quantitative analysis (expository studies); 2) a multivariate quantitative study where data is collected and a model is developed; and multiple regression analysis are undertaken over those variables; 3) narrowly focussed quantitative studies involving multiple actors where only a few variables are examined and use regression and correlational analysis; 4) multivariate non-quantitative study where it studies the evolution of multiple actors; and 5) multivariate quantitative studies (Miller and Friesen 1982, 1019-1020). The present thesis is an expository study.

5.3 Data Collection

To get an insight on innovation / technological capability in Malaysia, the primary indicative policy document initiated by the Malaysian policymakers, i.e., Malaysia Plans from the first in 1965 to the latest in 2016, Given its importance, a deduction derived from the fact that the plans were used from pre-independence years as a primary economic planning document, these documents were selected as the primary data source. This thesis studied how these plans contributed to the planning, implementing, evaluating, and correcting Malaysia's innovation / technological capability development. The longitudinal analysis of the policies and strategies undertaken to develop innovation / technical capability within the Malaysian Innovation System to observe the changes and identify lock-ins will provide rich insight to Malaysian policymakers, which may lead to a policy change in the future.

The primary data source was obtained online from the Malaysian Prime Minister's Office. Additionally, statistical data from both the Malaysian and International organisations, reports, and relevant scholarly works were used to understand the capability development path.

5.4 Data Analysis

Searching for answers to why Malaysia is struggling to graduate into high-income status, this thesis assessed Malaysia's approach towards developing its innovation / technological capability through a qualitative longitudinal study of all the indicative Malaysia Plans implemented till 2016. A qualitative longitudinal study in public policy, as discussed above, is not new. It is a powerful tool to analyse change and typically involves a vast data range. This method allows for a systematic study of factors to determine its changes and impact (Corden and Millar 2007b, 6). The data were compiled and classified into three segments: when Malaysia was in the lower-income classification, lower, and upper middle income. This segmentation allows a meaningful textual analysis of policies implemented by the Malaysian Development Plans, i.e., strategies and policies developed, implemented, evaluated, and corrected to build innovation capability. As highlighted below, the strategy and policies on innovation capabilities factors are analysed at each segment to understand whether the policymakers evaluated and corrected the paths to facilitate planned economic development.

This thesis analyses the information obtained from the primary data against the statistical data from Malaysian and International Organisations and scholarly works to determine whether the changes took place and how these changes promoted or hampered the development of innovation capability in Malaysia. This qualitative approach limited the possibility of considering factors other than those mentioned herein as those factors will involve primary data collation. As elucidated from the literature, the core idea is that when a country does not achieve innovation capability, it will be stuck in its economic development progression. Further, it is posited that this form of inquiry leads to a holistic understanding of the Malaysian innovation system in terms of capability development.

As alluded to earlier, this method of analysing data will provide an insight into how the innovation policies are operating to ensure that all actors are working cohesively to achieve the innovation capability development agenda.

5.5 Conceptual Framework

Literature suggested that education (quality and relevance) and educational institutions (research universities; research institutes; and institutes offering training) are the most significant contributors to developing innovation capability, which enhances competitiveness and invariably leads to improved economic performances (Wong and Fung 2019, Iqbal et al. 2015, Yusuf and Nabeshima 2009, Rasiah 2006, Chandran and Devadason 2017). Technological upgrading and diversification are pivotal to develop innovation capability, and these parameters can be achieved through spillovers which can be attained through linkages established by MNCs, circulation of skilled and technical workers from the MNCs into local organisations, and MNC trained local R&D workforce (Yusuf and Nabeshima 2009, Rasiah 2006). Further, as discussed in Chapter 1, the capability dimension and measures were used to develop the conceptual framework.

This thesis is focused on studying innovation capability development in Malaysia. The aim is to explore the policies and strategies developed and how these were implemented, evaluated and corrected to achieve innovation capability. In doing so, the dimensions of science, research, innovation, and skills were selected. These dimensions are directly relevant to capability development and can answer the research questions identified in Chapter 1. The assessed outputs are scientific publications, patents, R&D, innovation counts, education, and managerial and technical skills within the dimensions identified.

In analysing the data, the conceptual framework as identified in was **Figure 20** was adopted. This framework considered the economic goals and how these were translated into policies and strategies. According to these policies and strategies, the institutions and organisations and other relevant actors introduced to promote the objectives of the policies and strategies were traced. Whether these actors interacted and achieved the economic goals, these interactions are measured through the outputs. The more salient factor that this analysis brings to the fore is whether those policies and strategies intending to promote an economic goal were implemented, evaluated, and corrected throughout the study period. This analysis adds dimension and lends excellent insight into the possible drawbacks or policy lock-ins that may or may not impede the economic goals envisaged by the Malaysian policymakers.

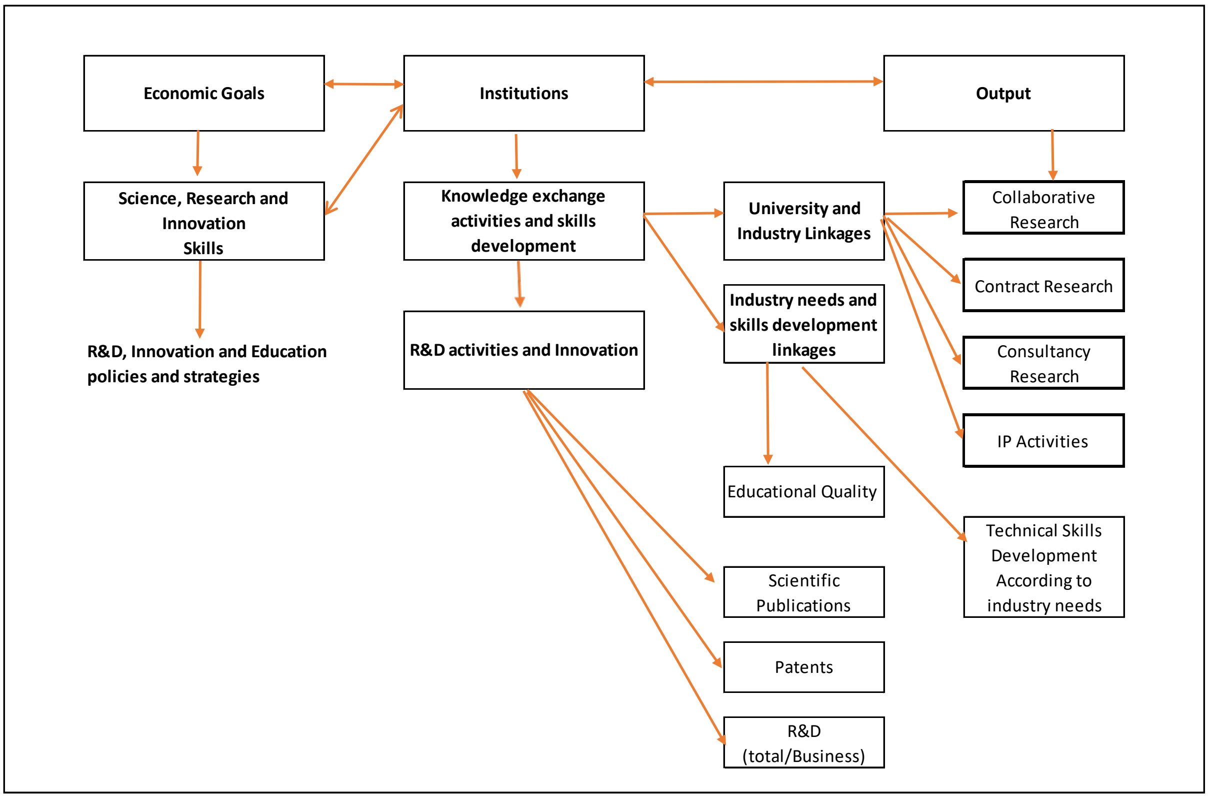

Figure 20 Conceptual Framework to trace Innovation Capability in Malaysia
Source: Adopted from Fagerberg, Srholec, and Verspagen (2010, 9) and Zhang (2018, 83)

This conceptual framework is limited in its scope as it intends to study how the policies and strategies related to the identified factors were deployed to develop innovation capability. The reason for selecting these variables to the exclusion of others is that these are the basic requirements for a country to promote innovation. It is argued that if the science, research and innovation, and skills policies are functioning systematically, this will lead to the industrial linkages and all related factors being equally developed and functional.

Once the institutions, agencies and relevant actors were identified, the interactions of these actors were traced to determine whether there is a common pursuit of the economic agenda or whether these actors were operating in silos without any interaction whatsoever. This form of analysis potentially brings to fore the disconnect with the actors within the system besides highlighting the neglect of monitoring and correcting the system when policies or strategies fail.

5.6 Limitations

This research, as mentioned above, is limited in its scope since other factors relevant for capability development has not been considered. It also does not include any quantitative regression modelling, which may empirically cement the finding. Additionally, the research is a desk-top review and may have not sufficiently captured the complexity of the subject matter without embarking on surveys through questionnaires. Future studies may triangulate the finding by surveying all the institutions identified in this thesis.

5.7 Ethical Considerations

This thesis did not involve any collation of data from human participants and therefore did not fall within the requirements of the National Statement on Ethical Conduct in Human Research.

5.8 Conclusion

In this Chapter, the choice of methodology and methods, i.e. the qualitative analysis utilising the methods of historical grounded and longitudinal policy analyses. As unpacked in the discussions above, the chosen methods allow for the study at a detailed level to understand the reasons for the policies undertaken by the Malaysian policymakers in promoting economic development vis a vis capability development. Based on the literature discussed in Chapter 2, a framework has been developed to analyse the data collected to determine the outcome achieved as opposed to those envisaged by the policymakers. The framework discussed the components of economic goals, institutions and outputs with sub-factors identified which will be utilised to analyse the data in Chapter 8.

Chapter 6: Evolution of Malaysia's Innovation System (1965-1990)

6.1 Introduction

This Chapter provides a synopsis of the data between 1965 and 1990, i.e. from MPs1 to 5. These plans were crucial in establishing an innovation system and setting the motion to innovation capability development. It is a historical narrative that may bring to the fore potential systemic lock-ins, which will be discussed in Chapter 8. This Chapter is the first of two that discusses the data gleaned from the Malaysia Plans that are relevant for answering the research question that this thesis set out in Chapter 1. The justification for resorting to the MPs as a primary data source is first explained in the forthcoming section. After that, the economic policies and strategies, institutions and specific areas of education and R&D are discussed for the period to 1990, when Malaysia was still a lower middle-income country.

6.2 Justification for Malaysia Plans as a data source

The data source for this thesis is the indicative Five-Year Plans utilised by the Malaysian policymakers consistently from 1966 to 2016. These plans are a centralised economic development planning tool used as the blueprint to navigate its national economic development. Having the same coalition party governing Malaysia since its political independence from the British until 2018, as discussed in Chapter 4, helped cement these Plans as the primary economic planning tool. Hence, these development plans are an important source of data given their extended use and offer rich historical knowledge that helps plot the Malaysian Government's approaches in shaping its National Innovation System (NIS) and innovation capability.

For ease of analysis, these MPs are divided according to the economic development status as per **Table 8**.

Economic Developmental Stages	Plans
Pre-lower-middle-income classification [24] **Status was recognised in 1978 when the classification was started.**	Malaysia Plan 1 [1965 – 1970] Malaysia Plan 2 [1971 - 1975] Malaysia Plan 3 [1976 - 1980]
Lower middle-income classification	Malaysia Plan 4 [1981 – 1985] Malaysia Plan 5 [1986 – 1990]
Upper middle-income classification [attained in 1992]	Malaysia Plan 6 [1991 – 1995] Malaysia Plan 7 [1996 – 2000] Malaysia Plan 8 [2001 – 2005] Malaysia Plan 9 [2006 – 2010] Malaysia Plan 10 [2011 – 2015] Malaysia Plan 11 [2016 – 2020]

Table 8 Mapping of Malaysia Plan against the Development Phase as classified by World Bank

Source: Compiled by the researcher

Other relevant policies acknowledged as drivers of the Malaysian government development plan are identified in **Table 9.**

[24] All classification as per the World Bank classification system. World Bank (WB) classification was introduced in 1978, and at its inception, Malaysia was classified as a lower-middle-income country. However, initial growth plans need to be reviewed and analysed to understand the growth achieved up to 1978.

	MALAYSIA PLANS	OUTLINE PERSPECTIVE PLAN	INDUSTRIAL MASTER PLAN	Science, Technology and Innovation Policy
MAPPING OF POLICIES	1 [1965-1970]	1 [1970 - 1990] originated from the National Economic Policy (NEP)		
	2 [1971-1975]			
	3 [1976 - 1980]			
	4 [1981-1985]			
	5 [1986 -1990]		Industrial Master Plan 1 [1986-1995]	1st National Science and Technology Policy [1986-1989]
	6 [1991-1995]	2 [1991 -2000] National Development Policy (NDP successor of NEP) & Vision 2020 Policy (1991)		The Industrial Technology Development: A National Action Plan [1990-2001]
	7 [1996-2000]		Industrial Master Plan 2 [1996-2005]	
	8 [2001-2005]	3 [2001-2010]		The Second National Science and Technology Policy and Plan of Action [2002-2010]
	9 [2006-2010]		Industrial Master Plan 3 [2006-2020]	
	10 [2011 - 2015]	New Economic Model implemented through Economic Transformation Programme		National Policy on Science, Technology & Innovation (NPSTI) [2013-2020]
	11 [2016-2020]			

Table 9 Mapping of Policies against Malaysia Plans

Source: Compiled by the researcher from the source documents

Malaysian policymakers used a combination of long-term, medium-term, and targeted policies to drive economic development goals. The Outline Perspective Plans (OPP) set the long-term economic agenda. Three OPPs have been deployed to date, the first was for 20 years and the remaining for ten years each. Next, the medium-term plans are five yearly plans which implement the OPPs. Also, specific policies such as the Industrial Master Plans, and the Science, Technology, and Innovation policies, were used for particular agendas. This thesis refers primarily to the medium-term plans and, to the extent relevant, the other plans and policies to answer the research question identified in Chapter 1.

The Malaysia Plans attribute their genesis to the Economic Planning Unit (EPU) under the Prime Minister's Department. Each Plan results from an interactive process involving a broad range of stakeholders. The First Malaysia Plan (MP1) was the first centralised development plan. It had 16 chapters totalling 189 pages. Subsequent plans evaluated the preceding Plan, including the components discussed in MP1. These plans across the years evolved both in volume and content. They were initially comprehensive and supported by reliable data. However, after MP5, it became thin and lost its precision, making the value of these documents questionable. These documents are public, and the policymakers' motivation to reduce solid data is an issue that requires exploration. However, this inquest is not part of this thesis. The MPs are listed in **Table 10**.

The importance of these plans as an essential policy tool is sealed by the fact that they were prepared after consultation with various stakeholders and tabled in Parliament and was the primary reference point for the various Government and private sector actors. When MP1 was tabled in Parliament, the then Prime Minister Tunku Abdul Rahman accentuated the importance of the Plan by stating the follows:

> *The achievement of the Plan' will require determination, self-reliance, and sacrifice for the sake of a better life and a secure economic, social, and political future. The Government does not conceal the immense problems with which the nation is confronted but accepts the challenge of development and will play its role in the attainment of a better, happier, and more peaceful life for all Malaysians... It is my hope that Malaysians, whose magnificent response and enthusiasm have been responsible for the success of the country's development programs in recent years, will continue to participate in this great development effort under the First Malaysia Plan....* ***I am confident that this Plan will receive the full cooperation and support that it deserves for the good of the people and future generations*** [emphasis added]*. In submitting this Plan for adoption by both the Dewan Ra'ayat*[25] *and Dewan Negara*[26]*, I wish to record my appreciation of the good work of the Chairman, Dato' Abdul Jamil bin Abdul Rais, and members of NDPC*[27]*, the officials of the Central and State Governments and public authorities as well*

[25] House of Representatives
[26] Senate
[27] National Development Planning Committee

as the representatives of the private sector all of whom have given generously their time and views.

Excerpt from MP1 (1965, vi).

At the same time, these development plans double as a political tool for ruling governments to garner the support of the majority of the voting populace through the pursuit of a populist socio-political development agenda, garnering publicity (Tan and Aslam 2012).

	MP1 [1965-1970]	MP2 [[1971-1975]	MP3 [1976-1980]	MP4 [1981 -1985]	MP5 [1986-1990]	MP6 [1991 - 1995]	MP7 [1996-2000]	MP8 [2001 -2005]	MP9 [2006-2010]	MP10 [2011 -2015]	MP11 [2016-2020]
Chapter 1	Malaysian Economic Development - Position, Problems and Plans	The New Development Strategy	The New Economic Policy: Goals and Strategy	Policy Objectives and Framework	Policy,Objectives and Framework	Policy Objectives and Framework	Policy Objectives and Framework	Policy Objectives	The Ninth Malaysia Plan: The First Step in the National Mission	1Malaysia: Charting Development Towards a High-Income Nation	Eleventh Malaysia Plan: Anchoring growth on people
Chapter 2	Progress of the Economy in Recent Times	Review of Past Progress	Review fo the Second Malaysia Plan, 1971-75	The Growth and Structure of the Malaysian Economy	Macro-Economic Performance, 1981-85 and Prospect, 1986-90	Public Sector Programme and Its Financing	Macroeconomic Performance and Prospects	Macroeconomic Performance	Macroeconomic Stability for Growth	Building on the Nation's strenghts	Strenghening Macroeconomic resilience for sustained growth
Chapter 3	The Context and Framework of the First Malaysia Plan	Economic Balance	The Third Malaysia Plan, 1976-80: Ojectives and Policies	Progress of the New Economic Policy	The New Economic Policy Progress and Prospects	Agriculture Development	Poverty Redressal, Restructuring of Society and Income Distribution	Poverty Eradication and Restructuring of Society	Strenghtening Agriculture and the Agro-Based Inndustry	Creating the Environmnet for Unleashing Economic Growth	Enhancing inclusiveness towards an equitable society
Chapter 4	The Public Sector Programme and Its Financing	The Framework of the Second Malaysia Plan	Outline Perspective Plan, 1971-90	The Devrelopment of Human Resources	Population, Labour Force and Employment, and Manpower Development	Industrial Development	Population, Employment and Manpower Development	Population, Employment and Human Resource Development	Upscaling Manufacturing and Related Services	Moving Towards Inclusive Socio-Economic Development	Highlights Tenth Malaysia Plan 2011-2015: Achievements
Chapter 5	Employment and Manpower for Development	The Public Sector Programme and Its Financing	The Sociological, Political and Security Dimensions of Development	Regional Development	Regional and Urban Development	Education and Training	Regional Development	Regional Development	Manstreaming Information and Communications Technology	Developing and Retaining a First World Talent Base	Accelerating human capital development for an advanced nation
Chapter 6	Administrative Machinery for Planning and Implementation	The Role of the Private Sector	Macro-Economic Framework, 1976-80	Public Sector Programme and Its Financing	Role of the Private Sector	Science and Technology	Public Sector Programme and Its Financing	Public Sector Programme and Its Financing	Biotechnology for Wealth Creation	Building an Environmnet That Enhances Quality of Life	Pursuing green growth for sustainability and resilience
Chapter 7	Agriculture and Rural Development	Employment and Manpower Development	Prices: Trends, Problems and Policies	The Private Sector: Its Role in National Development	Public Sector Programme Financing and Implementation Machinery	Trade	Privatisation	Privatisation	Vibrant Financial Services	Transforming Government to Transform Malaysia	Sternghtening infrastructure to support economic expansion
Chapter 8	Manufacturing, Construction and Mining	Administrative Machinery for Planning and Implementation'	Population, Employment and Manpower Development	Nation Building and National Unity	Science and Technology	Tourism	Agricultural Development	Agricultural Development	Realising Tourism Potential		Re-engineering economic growth for greater prosperity
Chapter 9	Transport and Communications	Agriculture, Forestry and Fishing	Poverty Eradication and Radical Economic Balance	Prospects and Strategies for the Eighties	Environment	Finance, Banking and Insurance	Indusrial Development	Industrial Development	Thriving Distributive Trade		Transforming public service for productivity
Chapter 10	Utilities	Manufacturing	Regional Development	Organising for Development	Agriculture and Rural Development	Transport and Communication	Education and Training	Infrastructure and Utilities	Streamlining Privatisation		Malaysia Beyond 2020
Chapter 11	Education and Training	Commerce, Tourism, Mining and Construction	Dvelopment and the Environment	Macro-economic Framework	Manufacturing	Energy	Infrastructure and Utilities	Energy	Enhancing Human Capital		
Chapter 12	Health and FamilY Planning	Transport and Communications	The Public Sector Programme and Its Financing	Population, Employment and Manpower Development	Trade	Water Resources	Energy	Science and Technology	Harnessing Science, Technology and Innovation		
Chapter 13	Social and Community Services	Utilities	External Assistance and Regional Co-operation	Public Sector Programme and Its Financing	Finance	Health	Science and Technology	Information and Communications Technology	Women and Development		
Chapter 14	General Administration	Education and Training	Administrative Machinery for Planning and Implementation	Role of the Private Sector	Tourism	Social Development	Information Technology	Finance	Empowering youth for the Future		
Chapter 15		Health and Family Planning	The role of the Private Sector	Agriculture, Livestock, Fisheries and Forestry	Mining	Environment	Finance	Tourism	Fostering Family and Community Development		
Chapter 16		Social and Community Service	Agriculture, Animal Husbandary, Fisheries and Forestry	Manufacturing	Transport and Communication	Women in Development	Tourism and Distributive Trade	Distributive Trade	Achieving Growth with Distribution		
Chapter 17		General Administration	Manufacturing	Commerce, Finance, Real Estate and Tourism	Energy	Administrative Improvements	Health	Health	Attaining Balanced Regional Development		
Chapter 18			Mining	Mining	Public Utilities		Housing and other Social Services	Housing and other Social Services	Improving Infrastructure, Utilities and Urban Transportation		
Chapter 19			Housing	Transport and Communications	Education and Training		Environment and Sustainable Resource Management	Environment and Sustainable Resource Management	Sustainable Energy Development		
Chapter 20			Transport and Communications	Energy and Utilities	Health Services		Women and Development	Women and Development	Achieving Better Health		
Chapter 21			Utilities	Education and Training	Housing		Youth in Development	Youth in Development	Providing Quality Housing and Urban Services		
Chapter 22			Education and Training	Housing	Social Development			Development through International Cooperation	Promoting Environmental Stewardship		
Chapter 23			Health and Family Planning	Health and Social Welfare	Defence and Internal Security			Administrative Improvements for Development	Enriching Culture, Arts and Heritage		
Chapter 24			Community Services and General Administration	Culture, Community Development, Security and General Administration					Developing A Sports Culture		
Chapter 25									Good Governance for Development		
Chapter 26									Efficient Public Service Delivery System		
Chapter 27									Development through International Cooperation		

Table 10 Table of Content of all Malaysia Plans

Source: Compiled by the Researcher from the Malaysia Plan

6.3 Pre-Lower- Middle-Income-Classification

This section will identify the economic policies and institutions created between 1965 and 1980. In doing so, policies and strategies related to science, research, skills, and education will be unpacked. This data will be used in Chapter 8 to determine whether interactions between the institutions existed, knowledge exchange activities materialised, skills development and R&D activities, and innovation were achieved, leading to innovation capability development.

6.3.1 Economic Goals Review of Malaysia Plans 1 - 3, 1965–1980

Malaysia had a direct entry as a lower middle-income country when the World Bank income classification was introduced in 1978. It had a relatively high income as the 50 percent world supplier of rubber and tin (Drabble and Whaples 2004). The new politically independent state aimed for the first 15 years to achieve 1) a per capita income of $1,500 by 1985; 2) high employment rates by 1985; 3) to bridge the gap for low-income groups; 4) high social and community services; 5) basic economic infrastructure; and 6) population growth control (MP1 1965, 14-15) as laid down in the Outline Perspective Plan (OPP). OPP1 [1971-1990] and operationalised by MPs 1, 2 and 3.

MP1 was significant since it was the first to plan holistically for the newly formed independent state (Lim 1982). Its main agenda was 1) integration of people and states to increase income and consumption per capita; 2) improve rural communities well-being; 3) reduce unemployment; 4) diversify economic activities; 5) upskill labour (MP1 1965, 1); 6) slow population growth; 7) develop new land schemes for new farm families; and 8) provide sufficient infrastructure, i.e. electricity, transportation and communication services (MP1 1965, 2), which were basic growth plans.

It promoted diversification to end a heavy reliance on rubber and tin to overcome price volatility and depleting supplies, making the sector unsustainable as a long-term economic driver (MP1 1965, 36). New economic activities were necessary to increase export earnings and import substitution to reduce the foreign exchange deficit caused by the high consumption of imported goods and services. The structural change began with low-end manufacturing and infant industries (MP1 1965, 123-124). A means of achieving this change was by attracting foreign entrepreneurs through *inter alia* investment guarantee agreement incentives and dispute settlement protection[28] by becoming a signatory to the Convention of Investment Disputes (MP1 1965, 131)[29]. Besides continuing unrestricted repatriation of capital and remittance of profits and dividends within the Sterling Areas and nominally controlling countries outside the Sterling Area to encourage foreign investment. Further, agreements for relief from double taxation were secured in selected countries (MP1 1965, 131).

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[28] Through providing access to International Arbitration and Conciliation Centre
[29] Malaysia became a signatory on Oct. 22, 1965, and it took force on Oct. 14, 1966

This economic agenda in MP1 made way to the New Economic Plan (NEP), a policy initiated in MP2 against the backdrop of the 1969 racial riots (discussed in Chapter 4). NEP promoted social integration and equitable distribution of income and opportunities prompting MP2 to promote a social-democratic reformist agenda. Hence, MP2's primary agenda was to correct the imbalances in income distribution, employment, and ownership and control of wealth – dubbed the "*economic balance*" agenda (MP2 1971, 36). The intent included correcting the racial shares in management and ownership and employment within the various economic sectors. As it stood, in the 1960s, the non-Malays and foreigners dominated the manufacturing and commercial sectors, and the target was to change that with Malays and other indigenous people holding at least 30 percent of it within the next 20 years (MP2 1971, 41). Employment patterns at all levels and sectors were to reflect the racial composition majority.

This reformist agenda became a default from MP2 onwards. The NEP aimed to eradicate poverty, regardless of race, and introduce social restructuring to ameliorate racial and economic imbalance. The NEP gave the Malaysian Government a 20-year time frame to eliminate the identification of economic activity to a particular race. It became the forefather of special rights and privileges of the Malays backed by the Constitution – resulting in a variety of protective policies which included subsidies, quotas, scholarships, and licensing and trade concessions to offset the disadvantage suffered by the Malays compared to the other races (Ozay 1986, 6).

MP2 focussed on improving social infrastructure, particularly building new schools and promoting science and technology education to provide rural students access to basic education necessary to enter science programs at higher levels and subsequently hold technical jobs. The agenda targeted Malays and other indigenous people and the poor of other races (MP2 1971, 45).

Following MP1, MP2 proposed structural changes by expanding industrial and critical service sectors correlated to increased employment. This heavy employment-driven strategy resulted in public sector projects being labour intensive. MP2 also focused on increased export production, new industrial and agricultural items, establishing local processing plants for domestic raw materials, and encouraging domestic products to substitute imports. The strategy to promote exports and import substitution continued (MP2 1971, 6).

The direct participation of the public sector through wholly-owned enterprises or joint ventures with the private sector were prevalent (MP2 1971, 7). This intrusive public participation in commercial and industrial activities departed from MP1 practice. It, however, supported the Government's goal to 1) establish new industrial activities in selected growth areas where private investments were lacking, 2) create a Malay commercial and industrial community, and 3) achieve geographical dispersal (MP2 1971, 7).

The manufacturing sector was the strategic sector for development to eradicate poverty and create a Malay commercial and industrial community (MP2 1971, 147). MP2 identified prospects for import substitution in the capital, intermediate, and consumer goods as the import of these products accounted for 45% of the domestic market (MP2 1971, 152). Whilst recognising the need to reduce imports, it noted that the production of these products would surpass domestic consumption to exports and increase the gross value of exports by 15 percent (MP2 1971, 152-153).

MP3 initiated the second phase of NEP implementation by focussing on 1) reduction of poverty in rural areas and urban poor, 2) expansion of social infrastructure, 3) increased share of Malay and indigenous people in economic activities, 4)raised the share of Malays and other indigenous people in ownership of productive wealth, 5) develop Malay and other indigenous people entrepreneurs, 6) foster domestic and foreign private investment, 7) extend the utilisation of human and natural resources, and 8) expand social and physical infrastructure (MP3 1976, 49-50). Economic expansion is induced through 1) private and public investment and 2) export growth (MP3 1976, 56-57).

At the inception of MP3, the manufacturing sector was the fastest-growing sector. The value-added growth was estimated at 12 percent per annum for 1975-80, increasing the share in GDP to 16.8 percent by 1980 (MP3 1976, 114). Besides meeting the goals of NEP, MP3 intended to: 1) promote efficiency, 2) create employment, and 3) develop small-scale industries (with Malay participation) (MP3 1976, 317). Further, a review of industrial packages to eradicate inefficient high-cost industries' sheltering was pursued (MP3 1976, 318).

MP3 identified new emerging industries to provide additional thrust to the industrial sector. Besides increasing the processing and fabrication of rubber and timber products, the substantial oil and natural gas resources made it possible to explore several large-scale industries to produce petrochemicals and petro-chemical by-products, including fertilisers (MP3 1976, 318). The promotion of industrial development prioritised raw material-based industries. Further, the metalwork industry was encouraged due to industrial progression; however, the availability of skilled labour was a concern. MP3 recognised that capital goods manufacture required improvement in education and vocational training in industrial engineering.

The main policy initiatives under MP3 were to provide fiscal incentives to encourage labour-intensive, resource and export-oriented industries and regional development (MP3 1976, 317). Since growth depended on export-oriented industries, MP3 intended to make these industries efficient and competitive in the world market

(MP3 1976, 317). In principal industries, export incentives were promoted through the *Investment Incentives Act 1968 inter alia* in electrical and electronics, textiles and clothing, food manufacturing, and wood products industries (MP3 1976, 313). This exercise led to the electrical and electronics industry becoming the propeller of the economy.

6.3.2 Major Institutional and Governance changes

The primary institution that merits discussion is the National Development Planning Committee (NDPC), established to plan and coordinate economic and social programs. The NDPC was supported by the Economic Planning Unit (EPU), formerly Economic Secretariat (MP1 1965, 90). The NDPC oversaw policy matters, i.e., formulation, implementation, progress evaluation, and revision of development plans and EPU supported with secretariat services. Further, an advisory committee was formed to support NDPC by providing advice on private sector development. This institution is pivotal to determine whether it implemented, evaluated and corrected policies over time.

The NDPC was headed by a government appointee who was also a member of the Cabinet. The NDPC's terms of reference were to 1) formulate and review all national development plans and recommend resource allocation, 2) review causes of delays and difficulties in the implementation of national development plans and propose solutions, 3) ascertain adjustments necessary in national development plans given changes in the economic situation, 4) use discretion to decide or refer to the Cabinet or the Economic Committee of the Cabinet on economic matters, 5) evaluate matters submitted to the Cabinet by Ministries and Departments which had a direct or indirect impact on development, and if considered necessary, advise Cabinet on the developmental aspects of each matter (MP1 1965, 90).

The advisory committee to the NDPC consisted of representatives from the private enterprise, employer associations, and trade unions. It was a platform that engaged with private sector stakeholders when conceiving plans and policies for development (MP1 1965, 91). The planning and research sections of central Ministries also supported the NDPC (MP1 1965, 91) and several sub-committees, e.g. Estimates sub-committee (MP1 1965, 94). **Table 11** provides a summary of these institutions and their functions.

Bodies	Functions
National Development Planning Committee (NDPC)	Evaluate the details of policy challenges
Economic Planning Unit (EPU)	Provide secretariat services to NDPC
Advisory Committee	Advised NDPC on matters related to the development of the private sector

Table 11 Summary of Planning Policies

Source: Compiled by Researcher referring to MP1

According to the aim of encouraging foreign investors, MP1 established measures and institutions as listed in **Table 12** (132-136):

Policy and Bodies	Details of Measures
Protective Tariffs **Regulatory Body: Malaysian Tariff Advisory Board (1963)**	Temporary protection for infant industries and 214 items.

Tax incentives	Granted for pioneer industries and capital investment
Industrial Credit **Financial Institutions:** **Malaysia Industrial Development Finance Ltd (MIDFL)** **Malayan Industrial Estates Limited (MIEL) subsidiary of MIDFL**	Medium and long-term credit for industrial development. MIEL finances small industries to intensify factory building for sale on credit to entrepreneurs.
Small Scale Industries **Majlis Amanah Rakyat**[30] **(MARA)** **Bank Bumiputera**	Indigenous entrepreneur financing.
Industrial Site Development	Provision of access to essential utilities for development sites, e.g. roads, water, and power.
Industrial Training **Central Apprenticeship Board (CAB)** **Industrial Training Institutes (ITT)** **National Productivity Centre (NPC)**[31]	Produce trained technicians and supervisory personnel. NPC was established to train supervisory and managerial personnel at all levels.
Industrial Research **National Institute of Scientific and Industrial Research (NISIR)** **Malaysian Standards Institute**	It was formed to support research activities for industrial development. To concentrate on industrial standards and quality.
Leadership in Promotion and Coordination **Federal Industrial Development Authority**[32] **(FIDA) (1964)**	Coordinate industrial promotional activities and organisational relationships and conduct investor feasibility studies. These feasibility studies and findings of the National Institute of Scientific and Industrial Research (NISIR) were used to promote the industrial projects.

Table 12 Policy measures and organisations

Source: Compiled by the researcher based on MP1

MARA, the custodian of the NEP plan, is an institution that needs mentioning. It was established and allocated funds to induce Bumiputera Malays to undertake

[30] People's Trust Council

[31] Funded by the UN Special Fund

[32] is Currently known as the Malaysian Industrial Development Authority (MIDA)

education and training, obtain technical and financial assistance, establish and manage new industrial enterprises. Accordingly, MARA formed joint ventures with local and international organisations to develop industry and commerce to transfer these to the Bumiputera Malays later (MP1 1965, 137). It is the first of the many government agencies formed to encourage economic development generally and of Malays specifically (Abd Nasir, Razak, and Yaakub 2012, 1380). It is an ultimate trustee agency tasked to develop the Bumiputera Industrial and Commercial Community by *encouraging, guiding, training and assisting Bumiputera Malays* in commercial and industrial activities (Abd Nasir, Razak, and Yaakub 2012, 1380),

Following MP2's agenda of promoting racial balance, the policies in **Table 13** were introduced. These policies primarily focused on special rights to the Bumiputera group, particularly the Malays.

Policy	
Creation of Malay Entrepreneurial Community	Financial assistance is given to Malay entrepreneurs; to identify projects and supply advisory and technical services. Aim to create a Malay entrepreneurial community within one generation.
Business Premises and Physical facilities	Rural and land development programs for Malay and other indigenous traders
Promoting joint-ventures	Joint-ventures between the Malays and non-Malays
Small-scale industry service	Promote the development of small-scale industrial activity – especially important for Malays entering the industrial sector
Intensified research	New policies and new methods to achieve greater racial balance

Table 13 Economic Balance Policies

Source: Compiled by the researcher from MP2 (1971, 47-48)

MP2 also established the Private Sector Advisory Panel to the Capital Investment Committee (CEC) as formal consultative machinery to ensure relevant policy measures (MP2 1971, 118). Additionally, a new collaborative procedure to review operating expenses and development budgets between the Treasury, EPU, Development Administration Unit (DAU), Public Service Department (PSD), and Department of National Unity (DNU) were introduced (MP2 1971, 118).

Although MP3 promoted the private sector involvement in industrialisation, the public agencies continued to play an active role. The Federal Industrial Development Authority, formed through the passing of the Federal Industrial Development Authority (FIDA) Act 1965, was operational in 1967 and provided the machinery for promoting and coordinating industrial development. Its task included assisting investors in hastening the implementation phase of their projects (MP3 1976, 319). FIDA also collaborated with State Governments to coordinate industrial development (MP3 1976, 319). The overarching policy agenda for FIDA was the NEP - increasing the participation of Malays and other indigenous groups in new industries (MP3 1976, 320). **Table 14** summarises the institutions which were emphasised in MP3:

Agency / Body / Organisation	Year of Establishment	Objectives
Standard and Industrial Research Institute of Malaysia (SIRIM) [33]	1975 It is the merger of the Science and Industrial Research Division (formerly	Conduct research to improve the domestic application of a range of industrial technology to manufacture resource-

[33] Currently is known as SIRIM Berhad

	known as the National Institute for Science and Industrial Research) and Standards Division (formerly known as Standards Institution of Malaysia)	based products. The standards division was to develop and promote national standards for commodities, processes and practices in conformity with Malaysian standards (320)
Research agencies in Rubber research **Malaysian Rubber Producers Research Association (MRPRA)** **Rubber Research Institute of Malaysia**		Research on end-uses of rubber and rubberwood (320)
National Industrial Training Council	To be formed with representation from Government, employers and workers	To promote integrated training (320)
The Advisory Council on Consultancy and Advisory Services for Small-scale Industries and Businesses		To become the coordinating council for the development of small-scale industries. FIDA will be the secretariat acting as the go-between the private sector and governments and responsible for the formulation of measures for the development of the small-scale industries (320-21)
Perbadanan Nasional (National Corporation) [PERNAS]	1969 Drove the NEP and had the interest of Malays and other indigenous people at the heart of its operations	Involved in manufacturing projects including fertiliser, cement, telecommunication equipment and pharmaceuticals (321)
Petroliam Nasional Malaysia (National Petroleum Limited) [PETRONAS]	1974	To undertake projects in petroleum and Petro-chemical fields (321)
Metal Industries Development Centre of Malaysia [MIDCOM]	To be established	To oversee the supply of quality products in the market by local producers (322)

Bumiputera Investment Fund	Was to be established during the MP3 period.	To promote increased share ownerships of Malaysia and other indigenous people within the corporate sector (trustee framework)(322)
National Council for Scientific Research and Development (NCSRD)	1975	Closer coordination of policies and programs in education and training (405)

Table 14 Summary of the Main agencies for Development under MP3

Source: Compiled by the researcher from MP3

6.3.3 Education and Training

The first course of action for the newly independent state following the Education Review Committee Report (1960) was abolishing school fees for primary education and increasing the school leaving age to 15 in 1965 (MP1 1965, 164). Changes at the tertiary level were aimed to increase the supply of teachers for primary education, students for higher education, and middle-level technicians. In 1962, the Higher Education Planning Committee (HEPC) was formed, and it estimated and planned workforce requirements for the coming 20 years by surveying in 1965 (MP1 1965, 164). This task was subsequently transferred to the Manpower Planning Unit (MPU) established within the EPU (MP1 1965, 164).

MP1 education programs were as per **Table 15** below (167 -171):

Type of Education	Strategies / Programs
Primary Education	All children to obtain primary education; increase and expand facilities; supply qualified teachers, and reduce early withdrawal
Secondary Education	Changes to meet specialised needs of agriculture, commerce and industry; increase

	enrolment in secondary level; introduce a new comprehensive system of education – where general education with a vocational or technical emphasis on industrial arts, agricultural science, commercial studies and home science; and establishing upper-secondary vocational schools.
Tertiary Education	Expanding the College of Agriculture; establishing the technical college and polytechnics for technical needs and University Malaya to supply professional staffing.
Teacher Education	Improvement and expansion of teacher training facility (priority); and new colleges and regional training centres.
Other Education and Training Programs	The National Productivity Centre (NPCtrain existing management personnel; training craftsmen and artisans; and other government specialised training.

Table 15 Education and Training Program, MP1

Source: Compiled by the researcher from MP1

A start point for a glimpse of human resources supply between 1980 and 1970 **(Table 16)** can be elucidated from the educational output trends in Malaya (MP1 1965, 83).

Level of attainment at the completion of education	**Number completing education**				
	1960	**1965**	**1967**	**1968**	**1970**
University	47	657	740	1050	1700
Technical and agricultural colleges	99	203	230	250	330
Sixth Form (and Muslim college)	692	1756	4900	6150	5870
Teachers Colleges	2130	2531	6200	6310	7160
Upper secondary	9724	14494	23870	23920	54370
Academic	9338	13728	23200	22960	41580
Technical	107	306	480	560	4180
Vocational	279	460	190	400	8590
Lower Secondary	4782	23752	38200	73400	99100
Primary	140947	45309	30800	26100	20900
Total	158421	88702	104950	137180	189410

Table 16 Educational Output Trends in Malaya

Source: MP1 (83)

The educational attainment trend from 1960 to 1970 indicated a shortage of technical and vocational qualified workforce, although the academic stream improved markedly. The general overview of the educational attainment levels suggested a promising workforce supply. These output patterns and the high demand for graduate-level teachers for upper and post-secondary schools (MP2 1971, 106) and skilled blue-collar workers prompted education reform. Most reforms focused on science, technical and vocational education, upgrading and expanding educational facilities, and pre-vocational skills(MP2 1971, 107). Reforms were expected to address the demand shortages in crucial labour areas, e.g., public administration, business management, science, and technology.

Besides the formal education system, several training bodies were established and empowered during MP1. In 1967, the NPC, which provided short-term courses and seminars in technical and management areas, was made quasi-autonomous (MP2 1971, 228). However, the primary institute for business management skills training was the Management Institute of Malaysia (MIM), established in 1966 (MP2 1971, 228). The Public Services Department also introduced a training arm to conduct development programs for its staff. Industrial training through apprenticeship and preparatory trade courses was run by the Industrial Training Institute under the Ministry of Labour and Manpower. This institute, however, suffered from a shortage of qualified instructors, which need was resolved in 1968 with assistance from UNDP (MP2 1971, 229).

A parallel goal for the development of ethnic Malay youths as part of the NEP agenda saw the establishment of four vocational institutes between 1965 and 1970 to offer technical courses besides sponsoring students abroad for vocational training. The National Youth Pioneer Corps, established in 1966, provided disciplinary and skills training in 8 trade areas, including motor mechanics, tractor driving and maintenance, and tailoring (MP2 1971, 230).

To develop industrial training, a National Advisory Council on Industrial Training (NACIT) was established to cooperate and coordinate industry and government relationships. It had representatives from both government agencies and various sub-sectors of the industry. It provided accreditation through the Malaysian National Trade Certification Board (MNTCB), which evaluated and certified skills levels to ensure uniformity and comparability to trade standards (MP2 1971, 241).

Table 17 summarises the agencies that were established in MP1 for education and training purposes:

Name of Institute / Agency / Organisation	Year	Purpose
National Productivity Center (NPC)	1962	Offered short term courses and seminars on management
Management Institute of Malaysia (MIM)	1967	Business management skills training
Training and Career Development Division	1969	Public service training needs
Industrial Training Institute (ITI)	1964	Provide preparatory trade courses for school-leavers

Training Division of MARA[34]	1956	Introduce and inculcate a sufficient level of trade and craft skill to rural Malays and other indigenous youths
National Youth Pioneer Corps (NYPC)	1966	Disciplinary and skill training for those who cannot gain admission for other formal training programs
National Advisory Council On Industrial Training (NACIT)	1972[35]	To act as the go-between the industry and Government
Malaysian National Trade Certification Board (MNTCB)		Evaluate and certify levels of skills

Table 17 Summary of Institutes

Source: Compiled by Researcher (MP2 1971)

MP2's primary objective was to align education and training programs with labour demand patterns and a capable and quality workforce supply. It set out four goals for 1971-75, as per **Table 18**.

	OBJECTIVE	MEASURES
1	Consolidate education system for national integration and unity	1. Adopt Bahasa Malaysia as the primary medium of instruction at schools 2. Bridge gap among regions and races 3. Integrate the East Malaysian education system into the national system
2	Orientate and expand education and training programs to meet workforce needs	
3	Improve the quality of education-oriented towards science and technology	
4	Improve research, planning and implementation capability	1. Evaluation of the situation in 1970 2. To establish a Science Education Centre to improve

[34] Today is known as University Technologi MARA

[35] Abdul-Aziz et al. (2008, 260)

	curriculum design and teaching of science and mathematics. It will be responsible for modifying the science and mathematics curricula and designing effective teaching methods in schools.

Table 18 MP2 Objectives, 1971-75
Source: MP2 (1971)

Some of the leading Industrial and vocational training and educational programs were intended to expand, upgrade, and accelerate industrial and vocational training and educational programs. At MP2, about 70 percent of new workforce entrants had post-primary education. However, there was an imminent need to expand institutions' capacity to train engineering and technical personnel. The enrolment and output of engineers needed to be increased, which resulted in a significant number of graduates being trained overseas (MP2 1971, 106). Besides, increasing the supply of graduate-level teachers for upper and post-secondary schools (MP2 1971, 106).

Whilst MP1 focused on extending basic education, reorganising upper secondary education with comprehensive and post-comprehensive education, and balancing general academic and vocational, technical, and science education, MP2 intended consolidation for efficiency. By 1970, 90 percent of the school-aged population were enrolled in primary education, achieving the target (MP2 1971, 224). This achievement was primarily due to the teacher training program, which produced

7,500 primary schools, 7,450 secondary schools, and 739 specialist trained teachers. The output of trained graduates for science and mathematics for upper and post-secondary education was still lacking at this stage (MP2 1971, 225).

Between 1966 and 1970, two new Universities were established, i.e. University Kebangsaan Malaysia (UKM) and University Sains Malaysia (USM), but lacked facilities and instructors (MP2 1971, 225). These institutions facilitated increased enrolment at higher education levels, but enrolment in engineering studies was still lacking though pivotal for advancing manufacturing.

By the end of MP2, as observed in **Table 19**, enrolments in primary grew by 12.8 percent, and lower and upper secondary grew by 54.5 and 85.4 percent, respectively. Concurrently, university enrolment increased significantly, particularly in science and technical courses. Polytechnics were established to provide training for the mid-level technical and commercial workforce. Whereas Institut Teknologi MARA (ITM)[36] progressed to increase the supply of qualified Malay and other indigenous workforce at professional and sub-professional levels.

DEVELOPMENTS IN THE EDUCATION SYSTEM 1970-1980					
	Enrolment			**Increase**	
Primary	**1970**	**1975**	**1980**	**1971-75**	**1976-80**
Peninsular Malaysia	1,421,469	1,586,909	1.815.600	11.6	14.4
Sabah	110,607	133,179	166,140	20.4	24.7
Sarawak	150,111	177,100	227,300	18.0	16.4

[36] Today is known as University Technologi MARA

Total	1,682,187	1,897,188	2,209,040	18.0	28.3
percent of all levels	75	68	64	12.8	16.4
Lower Secondary					
Peninsular Malaysia	378535	561471	676,100	48.3	20.4
Sabah	25068	41835	68,492	66.9	63.7
Sarawak	17041	46400	67,530	172.3	45.5
Total	420644	649706	812,122	54.5	25.0
percent of all levels	18.9	23.3	23.7		
Upper Secondary					
Peninsular Malaysia	84925	153415	241900	80.6	57.7
Sabah	3619	6518	16743	80.1	156.9
Sarawak	4384	7120	19130	62.4	168.7
Vocational and Technical	4899	14338	25920	192.7	80.8
Total	97827	181391	303693	85.4	67.4
percent of all levels	4.4	6.5	8.9		
Post-Secondary					
Peninsular Malaysia	10619	16335	35970	53.8	120.2
Sabah	272	293	618	7.7	110.9
Sarawak	641	1360	2320	112.2	70.6
Total	11532	17988	38908	56	116.3
percent of all levels	0.5	0.7	1.1		
Teacher Training					
Primary	1435	2735	7680	90.6	180.8
Secondary	1123	3544	4260	215.6	20.2
Sabah	630	782	924	24.1	18.2
Sarawak	699	879	2200	25.8	150.3
Total	3887	7940	15064	104.2	89.7
percent of all levels	0.2	0.3	0.4		
Diploma Level*	4993	16827	25578	237	52
Percentage of all levels	0.2	0.6	0.8		
Degree Level**	8331	14702	24258	76.5	65
percentage of all levels	0.4	0.5	0.7		
Total	2229401	2785742	3438663	25	23.1
*** includes enrolments in pre-university, preliminary and introductory courses at the respective colleges**					
**** includes enrolments in preliminary and introductory courses being offered at the respective universities**					

Table 19 Educational enrolments, 1970-1980

Source: MP3 (1976b, 385)

A human resources survey conducted in 1973 concluded 1) there was dispersion in educational achievements in the various occupations (MP3 1976, 154) and 2) need for other informal means to acquire skills (MP3 1976, 154). The survey findings were: 1) surplus growth of non-technical discipline graduates; 2) scientific personnel shortage; and 3) critical shortage of technical personnel. MP3 had to contend with meeting the expected 5.5 percent per annum demand for professional, technical, and scientific personnel. As a result, MP3 aimed to expand education and training to meet the National manpower needs in science and technology (MP3 1976, 138). It aimed for increased education quality and capacity in research, planning, and implementation. To facilitate capability development, the Ministry of Education sought to 1) increase primary and secondary school enrolments; 2) build residential science schools; and 3) increase upper secondary technical and vocational education enrolments in industrial trade, home science, agricultural science, and commercial courses.

Further, MP3 aimed to meet the demand for a qualified workforce with education and training programs incorporating on-the-job training features (MP3 1976, 154). Supported by the survey findings and the projected growth between 1976-1980, as per **Table 20**, MP3's priority was science, technical and vocational education and training, leading to tight control of intake in liberal Arts and Humanities at the university level.

	Total	Estimated requirements 1976-1980	Percentage of increase[37]
Professional and Technical	145517	65309	45%
Chemists and Physical Scientists	354	327	92%
Laboratory and Science Technician	3824	2137	56%
Architects and Town Planners	353	180	51%
Engineers	2244	2764	123%
Engineering Assistants and Technicians	11824	5538	47%
Surveyors	168	346	206%
Draughtsmen	2979	2041	69%
Agronomists	652	540	83%
Life Science Technicians	2070	1396	67%
Veterinarians	162	95	59%
Veterinary Assistants	352	127	36%
Medical Doctors	1915	728	38%
Medical Assistants	2323	2414	104%
Professional Nurses	5623	5279	94%
Dentists	379	205	54%
Dental Assistants	1030	578	56%
Accountants	1774	1971	111%
Lawyers	809	284	35%
Higher Education Teachers	1844	286	16%
Primary and Secondary Teachers	79527	19872	25%
Other Professional and Technical	20353	18183	89%
Administrative and Managerial	22605	12264	54%
Managers	12535	10472	84%
Clerical	129374	58755	45%
Sales	54041	31776	59%
Service	64917	145300	224%
Agricultural	105742	142309	135%
Farm Managers and Supervisors	7238	13701	189%
Production	210331	190123	90%

Table 20 Manpower Survey Results, 1973 and Estimated Requirements, 1976-80

Source: MP3 (1976b, 153)

[37] The researcher tabulated the figure

The enrolments in tertiary education by field of study were critical to understanding the available expertise level. The anticipated economic growth was contingent on a qualified workforce, particularly engineering, agriculture, health, education, and business. It was evident that by the end of 1975, the numbers enrolled for diploma and certificate courses in engineering (including petroleum engineering) doubled from 1970. There was also a considerable increase in science and technology and applied science (MP3 1976, 402). Consequently, at the degree level, enrolments in engineering (including petroleum engineering) had doubled from 1970, yet the numbers are considerably low. The highest enrolment was evident in science, science with education and applied science, which was pivotal as a supply of qualified science teachers to be fed into the school systems. Otherwise, there was a tendency for high enrolments on humanities and arts, which was not a promising trend (MP3 1976, 403).

Further, vocational training programs were emphasised and pursued through close coordination and integration of institutional and on-the-job training within the industry (MP3 1976, 395). To achieve its policy targets, MP3 undertook the following programs:

1. the development of personality, character and good citizenship and the promotion of moral discipline through curriculum and extra-curriculum activities (391);

2. the strengthening of science and mathematics teaching at primary and secondary levels of education. Further, expanding enrolments in science, technical and vocational courses to reflect 51.6 percent by 1980 (398); and
3. To prioritise diploma level courses to address the imbalance of degree and diploma enrolments, which is anticipated to quench the demand for the sub-professional level workforce (398).
4. Intake in liberal arts to be progressively reduced, and engineering, science, medical, agriculture and business courses emphasised (398).

6.3.4 R&D

This factor was not directly considered in MP1 though mentioned obliquely in the Industrial Policy section, where it was emphasised that research activity was pivotal for progressive industrial development (MP1 1965, 135). In this period, the National Institute of Scientific Industrial Research (NISIR) was established under the Ministry of Technology, Research, and Local Government to undertake research activity to support industrial development. NISIR supported industrial enterprises with scientific and technical research and studied possibilities and challenges associated with industrial processing materials (MP1 1965, 135). It conducted 1) feasibility studies, 2) research on industrial technology and 3) organised training programs to facilitate commercial and industrial development (MP2 1971, 178) besides functioning as an advisory arm to industrial enterprises on the appropriateness of technology and industrial processes. Contemporaneously, the Malaysian Standards

Institute (MSI)[38] was established to check compliance requirements of domestically produced and imported articles.

Similarly, MP2 did not consider the R&D factor directly though there was an emphasis on science, technical, and vocational education (MP2 1971, 73) – the vital ingredient for innovation capability. There was no single coordinated and streamlined approach to R&D that could be extrapolated from MP3 either. However, fragmented discussion of research in the various focus sectors was observed.

Measures were explicitly planned for the agriculture sector on end-use of palm oil (MP3 1976b, 53); rubber research (MP3 1976b, 257); land use and management (MP3 1976b, 233) and; forest management (MP3 1976b, 233), to state a few. MP3 lacked direct R&D initiatives (MP3 1976b, 248). Evidence of technical assistance was observed through bilateral sources, i.e. the Colombo Plan, technical and economic cooperation with Australia, Canada, India, Japan, New Zealand, and the United Kingdom (MP3 1976b, 248), technical assistance from the United Nations Development Program (UNDP), the Commonwealth Fund for Technical Cooperation (CFTC) (MP3 1976b, 248), and specialised agencies and foundations like Asia Foundation, the Ford Foundation, and the International Development Research Centre (MP3 1976b, 248).

[38] is Currently known as SIRIM Berhad

6.4 Lower-middle-income-classification

MP4 and MP5 [1981 – 1990] were operationalised when Malaysia was lower-middle-income. MP4 was launched amidst rapid economic growth, structural change, and a global recession (Narayanan 1996). It operationalised the first phase of OPP2, which extended policies and programs initiated under MP2 and MP3. The NEP agenda, which remained a primary economic driving force, was borrowed from the book 'The Malay Dilemma' authored by Dr Mahathir Mohamad (Dhillon 2009, 28-29, 32) incidentally began his career as the Prime Minister at the initiation of MP4. NEP was an economic policy and a political one (Souchou 2003, 217, Torii 1997, 210). The ideology articulated by Mahathir stirred the ethnic Malay sentiments, entrenching the idea that non-Malays had no claims to political, linguistic, and cultural parity with the Malays. There is an insurmountable debate on the lop-sidedness of this policy measure which has been dubbed an 'ethnicity-oriented-policy' (Torii 1997, 210). However, these debates are beyond the scope of this thesis and will not be considered at length – suffice to say that the implementation of this idea gained prominence in all economic policies under the leadership of Dr Mahathir Mohamad, and in turn, influenced the development of the innovation system in Malaysia. This reinforces the literature on innovation policies: that development of innovation system is non-linear, and political ideologies often translate into state policies, strategies, and programs that may provide an answer to the continual perpetuation of conflicting strategies and the proliferation of undesired consequences (Daneke 1998, 98-99), In this section, how policies, strategies, and programs were developed to facilitate to developing innovation capability will be explored.

6.4.1 Economic Goals Review of MPs 4 – 5, 1981-1990

MP4 promoted the Look East Policy (Jomo 2014, 87). The primary motivation was to imitate East Asian countries, particularly Japan and Korea. Dr Mahathir, on this policy, as quoted by Teh wrote the following:

> *"In the early 1980s, the Western nations appeared to have lost their drive. They were enmeshed in an oil crisis and seemingly unable to overcome economic stagnation at a time when vibrant new economic energy was virtually exploding in Japan, South Korea, and Taiwan. For me, it was a natural conclusion that if we were to emulate the success of foreign nations, the most valuable role models were no longer in Europe or the U.S., but rather in our own backyard. We had to look East."* (Teh)

Accordingly, the Look East Policy was a slogan to foster closer relationships with Asian nations, especially Japan. Mahathir, inspired by Japan Inc, master-minded the creation of Malaysia Inc to foster a partnership between the public and private sectors in developing the economy. He also envisioned the emulation of East Asian ethics, i.e., Bushido Code (Japanese) and Hwarang-do (Korean), both of which have their origins in the Confucian school of thought (Jeshurun 2007, 58, Abd Nasir, Razak, and Yaakub 2012, 58, Sundaram 2017, 87). Scholars have been astute in pointing out that emulation of “ethos by fiat” was not an achievable task, as it was enmeshed deeply in history and culture (Milne 1986, 1374). The Look

East Policy (LEP) aimed to achieve: 1) rapid industrial growth and 2) ethnic Malays becoming economic achievers (Saravanamuttu 1996, 2).

The Malaysia Incorporated Policy was introduced in 1981 under the LEP to encourage cooperation between the public and private sectors. Both sectors acted and operated with a *Malaysian Company* (Department). Mahathir defended this idea of "Malaysia Incorporated" in the following words at the official launch of his book "Malaysia Incorporated"[39]:

> *The idea of Malaysia Incorporated was based on the "Japan Incorporated", which is a close collaboration between the Japanese private sector and the Government bureaucracy. The international media regarded such collaboration as unethical and unhealthy. We do not see why such collaboration aimed at developing a country and its people should be bad. Despite the veiled condemnation, we decided to officially adopt this approach towards economic development and to describe ourselves as Malaysia Incorporated - Mohamad (1995)*

MP4 was deployed when considerable structural changes had occurred to the Malaysian economy (MP4 1981, 14). In this time, manufacturing recorded higher growth rates (MP4 1981, 14-15) and grew with the discovery of petroleum (MP4 1981, 17). By 1980, the manufacturing sector had increased its share in GDP to 20.5 percent, only slightly lower than agriculture (MP4 1981, 18). Labour-intensive industries received considerable incentives during the previous decade, contributing

[39] In the Japanese version.

to its exponential expansion (MP4 1981, 18). The sector's forerunners were textiles and electrical machinery, including electronics, recording rates of increase of 15.7 and 13.3 percent per annum, respectively (MP4 1981, 18). The export of electronics depended almost entirely on-demand from the parent companies in Japan and the United States (MP4 1981, 18).

The substantial expansion was undertaken in education and training during MP1 to MP3 to meet workforce demand for high and middle-level workforce in the scientific, technical, and managerial fields, resulting in a decline in the share of student enrolments in the arts discipline from 63.5 percent in 1970 to 47.8 percent in 1980, and an increase in science and technical courses from 36.5 percent to 52.2 percent (MP4 1981, 61). Although a considerable increase existed in the supply of sub-professional technical workforce, the acute shortage made it impossible to bridge the gap within the MP4 timeframe (MP4 1981, 60).

Technological changes began when capital goods, primarily machinery and equipment, were imported because of FDI, which encouraged new techniques, marketing, and management skills (MP4 1981, 80). However, these technological changes were conditional to the NEP objectives and managed by the Foreign Investment Committee (FIC). All proposed acquisition of assets or interests, mergers, or take-overs besides directly or indirectly improving efficiency achieve the NEP objectives, i.e., 30 percent Bumiputera holdings (MP4 1981, 80). Where this complies, a 40 percent tax incentive is given (MP4 1981, 81). Further, the *Industrial Coordination Act* 1975 was amended in 1977 and 1979 to encourage the development of the manufacturing sector by removing licensing requirements. As a result of this amendment, the Industrial Advisory Council was established to advise on matters concerning licensing (MP4 1981, 86).

MP4's focus remained on improving human capital as an economic and social input to 1) improve productivity and 2) shift employment patterns from primary agriculture to secondary and tertiary sectors for development (MP4 1981, 99). This focus innately pushed towards capital-intensive production methods, requiring increased access to technological capability, R&D activities, and foreign private investment to obtain technical and management expertise (MP4 1981, 99).

MP4 was the first to promote heavy industries in Malaysia actively. It pursued heavy industries inspired by the astounding success achieved by Japan and Korea, undertaking a similar development path. The heavy industry drive was spearheaded by the Heavy Industries Corporation Malaysia Berhad (HICOM), established in 1980, and was wholly owned by the Malaysian Government, to initiate, implement, and manage capital-intensive industries. It was intended to be flexible like the other private sector companies and agile to economic changes. HICOM was responsible for the iron and steel, aluminium reduction and cement plants, and engineering support services industries (MP4 1981, 193). It was provided with a launching grant of $125 million (MP4 1981, 193) and obtained financing from Japanese firms (Gomez 1997, 182). Implementing these projects encouraged private sector participation in industrial development, which otherwise would be absent since private capitalists averted such investment on their own, given the colossal capital investments and the protracted gestation periods (Gomez 1997, 182). HICOM was an interventionist economic strategy, prompted by an extreme pro-Malay stance and the "Look East" policy (Ritchie 2004, 14). It collaborated with Japanese companies to develop various industries ranging from steel and cement productions to the national car[40] (Gomez 1997, 182). To monitor HICOM and other non-financial firms, the Implementation and Coordination Unit (ICU) in the Prime Minister's Department was established as a 'watchdog'– where it had to review, evaluate, and approve financings for new projects. However, it proved to be powerless since most firms under ICU were powerful and relatively autonomous (Lim 1994, 248).

Although the creation of HICOM has no resemblance to the Japanese Model of industrialisation, it has similarities to the Korean Heavy and Chemical Industries and Construction Co (KHIC), which re-structured firms in the car manufacturing, fertilisers, and shipbuilding industries, when the Korean Government made headway into the heavy industries (Chang 2006, 115-116).

[40] This was introduced during MP4. However, MP4 does not mention any plans to pursue a national car. The only reference was where the Plan mentions an automobile and lorry assembly within the manufacturing sector (MP4 1981, 58). The national car is discussed later in this Chapter of the thesis.

The heavy industries were projected to integrate and strengthen linkages in the economy. In 1980, manufactured exports accounted for 27.5 percent of total exports, projected to increase to 41 percent by 1990 (MP4 1981, 101). MP4 recognised that the targeted increase posed challenges and required concerted effort in 1) the development of new export industries, 2) improving the competitiveness of existing and new exports, and 3) expanding into existing and new markets. Existing incentives and tariffs were reviewed as an initial effort to develop this sector. Additionally, a long-term master plan was conceived to develop the industrial sector consistently. This Plan was based on the findings of a sub-sectoral study undertaken and provided the basis for choosing industries for export promotion and import substitution (MP4 1981, 101).

Industry policy and promotional measures to stimulate the expansion of the manufacturing sector in export-oriented industries such as timber products, electronics, textiles, and rubber products were planned (MP4 1981, 127). Newly emerging products such as surgical and dental instruments and equipment, and scientific gauges were anticipated to have increased demand (MP4 1981, 127). The medical devices product segment emerged during MP4 and at a low-tech level, e.g. bandages, gloves, plastic syringes, catheters, and needles (Ming 2020, 8). Surgical instruments involved devices that assisted in surgical procedures such as forceps, medical scissors, dental drills, and specialised surgical instruments used in cosmetic and endoscopic surgery (Ming 2020, 8). These were opportunities for FDI by TNCs[41].

Skills, technical know-how, and entrepreneurship development were achieved by enhancing the role and capability of institutions such as Industrial Training Institutes, vocational institutes and schools, youth training centres, NPC, Universities, and colleges. The private sector was expected to complement the public sector efforts in building a skilled workforce, particularly in the manufacturing sector (MP4 1981, 145). To coordinate the cooperation and ensure the active participation of the private sector in training efforts, the Manpower Development Board (MDB) was established (MP4 1981, 145). MDB was tasked to 1) update the National Masterplan for Manpower Development and review the National Apprenticeship Scheme, and 2) formulate a scheme to incentivise the private sector when undertaking training activities (MP4 1981, 239).

Further, the Ministry of Labour and Manpower formed an Advanced Skill Centre to provide courses for 1) upgrading skills to master artisans; and 2) technicians, industrial supervisors, and instructors (MP4 1981, 145). Concurrently, plans to increase output at diploma and degree level graduates to satisfy the requirement of the trained and skilled workforce was implemented (MP4 1981, 239). According

[41] In the next Chapter, it will be seen that the Malaysian Government focused on the development of this industry in Malaysia, particularly channelling all FDI into a regional cluster development. Note that regional-cluster development is not within the ambit of this thesis; however, the development of this industry will be considered as an overall towards its contribution to the building of the Malaysian NIS.

to that Plan, courses at these levels were reviewed and aligned with national requirements (MP4 1981, 239). These measures were targeted to produce a 60:40 science to art student enrolment ratio (MP4 1981, 239). As for managerial and administrative training, *inter alia* NPC, INTAN, and ITM was involved. INTAN, however, facilitated public agencies, particularly 1) involved in national development; 2) less-developed states; and 3) departmental training.

Under the premiership of Mahathir Mohamad, several vital policies that dramatically restructured the Malaysian economic landscape were launched. The initial structural change witnessed the Malaysian economy transitioning from relying on commodities to manufacturing - low-end assembly works. The substantial push into export-oriented products led to the burgeoning of the electronics industry, credited to the FDI-led promotion strategy(MP5 1985, 49). Shortly after, another transition wave into heavy industry. **Table 21** traces the trails of this transition, which is essential in understanding the policy trajectory of the Government in MP5, focused on the development of innovation capability

Policy / Strategy / Program / Project	Year Initiated	Objective
Look East Policy[42]	Mid-1981	Designated Japan as the role model and promoted economic ties between the countries
Privatisation Policy[43]	1983	To lessen the financial and administrative burden of the Government, improve skills and production, accelerate economic growth, reduce size and involvement of the public sector; and achieve Malaysia's economic policy goals (Milne 1986, 1374, Sun and Tong 2002, 100)
Malaysia Incorporated	Mid-1981	Promoting the partnership between the private and public sector – heavily influenced by Japan Inc (Yusof and Bhattasali 2008, 17)
National Car Project (Heavy Industrial Policy)	1981 (formally established as PROTON – Perusahaan Otomobil Nasional Berhad[44] on May 7 1983) (Annuar and Rosland 2019, 208, Natsuda and Thoburn 2014, 1356, Wad and Govindaraju 2011, 153, Yusop, Wahab, and Saibani 2016, 1911)	Under the auspices of HICOM, launching Malaysia into heavy industry – pro-growth and heavy-industrialisation strategy (Kasipillai and Chan 2008, 43). It was aimed to develop supporting industries, upgrade technology and technical skills and provide affordable vehicles with Bumiputera participation (Natsuda and Thoburn 2014, 1356)

Table 21 Table of Policies in the Early 1980s

Source: Compiled by author from various sources

[42] This policy was followed by the "Buy British Last" campaign (Furuoka 2007, 508, Milne 1986, 1373) – which can be interpreted as a retaliation measure against the decision of 1) increasing university education fees for foreign students and 2) tightening of investment rules after Malaysia took over British-owned plantation company Guthrie (Furuoka 2007, 508).

[43] http://www.ukas.gov.my/en/public/background (accessed Sept. 14 2020)

[44] National Automobile Company Ltd

Following the heavy industries promotion, Malaysia launched its first national car[45] - quite a feat for a relatively new economy (Yusop, Wahab, and Saibani 2016, 1911). This was the result of a joint venture between HICOM, Mitsubishi Motor Corporation (MMC) and Mitsubishi Corporation (MC) of Japan, which aimed to increase local content, achieve economies of scale, and upgrade to manufacturing in the future (Yusop, Wahab, and Saibani 2016, 153, Wad and Govindaraju 2011, 677, Natsuda and Thoburn 2014, 1356). At the same time, it had to contend with a worldwide recession from 1981-1985, which recorded a lower GDP growth of 5.8 percent per annum. Yet this growth was reasonable given the economic slowdown in industrialised countries resulting in restrained external trade, reduced private investment, and increased imbalances in external payments (MP5 1985, 14). Private investments grew much slower, at 2.3 percent per annum between 1981 and 1985, which induced direct involvement from the public sector in commerce and industry through government-owned corporations (MP5 1985, 153).

During this time, the manufacturing sector underwent structural readjustments to sustain its importance in the economy. Amongst the readjustments were tariff structure changes aimed to encourage import substitution and the development of small-scale enterprises (MP5 1985, 153). Consequently, policies formulated were expected to increase the efficiency and competitiveness of the manufacturing sector

[45] In July 1985

(MP5 1985, 199). Further, the recommendations of the Industrial Master Plan and Industrial Policy Studies were the basis of new policies and regulations to improve and streamline administrative procedures (MP5 1985, 32).

Notably, MP5 faced an acute shortage of skilled and semi-skilled workers, finding a study undertaken in 1984 by the Ministry of Labour in industrial training schemes for the manufacturing sector (MP5 1985, 113). With the establishment of the Heavy Industry sector and the proposed move to high-technology industries, there was an imminent need for a quality and high-level workforce, which prompted the formation of the Centre for Instructor and Advanced Skill Training in 1984 (MP5 1985, 116).

Technical education gained popularity during MP4, derived from the increased number of enrolments from 5,500 in 1980 to 6,700 in 1985 (MP5 1985, 487). Science and technical courses' enrollment increased mainly in applied sciences, electronics engineering, computer science, and industrial engineering (MP5 1985, 115). In the same period, 26,800 students graduated with a degree, i.e. 12,000 in sciences and technical fields, the remaining in humanities, and 22,800 with a diploma (13,000 were sciences and technical studies) (MP5 1985, 115). The offer at technical school also expanded to surveying, engineering workshop practice, building construction, technical drawing, and commerce programs (MP5 1985, 487).

Structural changes were undertaken in the education and training system to produce the workforce required for economic development (MP5 1985, 148). Accordingly, course contents were reoriented and updated to facilitate the development of technology-driven skills needed for the industry (MP5 1985, 148). The program's success was evident when the enrolments in science and technical courses increased, improving the ratio between arts and science from 52:48 in 1980 to 50:50 in 1985. Intakes in applied sciences and engineering; electronics; computer science, and industrial engineering increased (MP5 1985, 149). Additionally, the skilled and semi-skilled workforce exiting from training institutes increased by 38.4 percent during 1981-1985 (MP5 1985, 152). However, skill-specific shortages and mismatches existed and a constant review was required (MP5 1985, 155).

Inroads were made in importing and utilising foreign technologies during MP4. **Table 22** gives a snapshot of the number of technology transfer agreements entered and registered with the Ministry of Trade and Industry (MITI) between 1981 and 1985. Evidently, a significant number of agreements were on technical assistance and know-how program in the food, electronic and electrical, and motor-vehicle industries (MP5 1985, 267-268).

Types of Agreement	1981	1982	1983	1984	1985	Total
Technical assistance and know-how	64	48	61	54	51	278
Joint ventures	22	14	14	17	9	76
Management	6	10	13	10	6	45

Trademarks/patents	8	8	7	18	5	46
Service	7	2	7	2	1	19
Basic Engineering	5	4	4	6	-	19
Others	19	8	55	12	24	118
Total	131	94	161	119	96	601

Table 22 Technological Transfer Agreements by Type, 1981-85

Source: MP5 (1985, 268)

Table 23 provides a breakdown of technology transfer based on industry group to provide an insight into technological developments in these industries.

Industry Group	1981	1982	1983	1984	1985	Total
Electronics and electrical	16	19	15	21	21	92
Motor vehicles and shipping	16	11	31	17	20	90
Chemical	21	5	15	17	`7	75
Food	12	1	37	6	10	66
Non-metallic	4	16	9	17	-	46
Fabricated metal	14	7	12	3	-	36
Basic metals	10	13	5	5	-	33
Rubber and leather	14	2	7	5	4	25
Hotels	2	4	8	7	4	25
Textiles	5	2	5	6	1	19
Plastics	6	1	2	7	-	16
Pulp, paper printing	-	4	1	6	3	14
Palm oil and petroleum	3	3	4	-	-	10
Scientific and optical equipment	-	3	5	-	-	8
Others	13	3	5	2	16	39
Total	131	94	161	119	96	601

Table 23 Technological Transfer Agreements by Industry

Source: MP5 (1985, 268)

MP5 pivoted towards high-technology industries, increasing the importance of research and development; however, the Malaysian Government's efforts to reduce expenditure on overseas education to save on foreign exchange impacted the direction, expansion, and development of education and training programs at the high and mid-levels (MP5 1985, 117).

Complex laws, regulations, and controls were streamlined to provide a conducive business environment for investors. Those rules and regulations that stifled the private sector's growth were phased out (MP5 1985, 22). Amendments to the Industrial Coordination Act (ICA) 1975 made it flexible and straightforward to administer whilst responsive to the business environment (MP5 1985, 22). The role of the public sector was reduced through the Privatisation Policy, which aimed to encourage the private sector to participate more effectively in economic development (MP5 1985, 22). It was an opportune time for Bumiputera entrepreneurs to participate in the commercial sector whilst moving towards achieving the Malaysia Incorporated drive introduced in MP4 (MP5 1985, 23). Further, foreign private investment was encouraged through liberal incentives and the removal of constraints.

The manufacturing sector's dismal growth of 4.9 percent per annum, short of the 6 percent target set during MP4, was due to the global recession, inherent structural weakness and required restructuring (MP5 1985, 333). Although manufacturing became the sector of choice in 1984, it fell behind in 1985 due to poor export performance and softened domestic demand (MP5 1985, 333). Despite the poor showing, MP5 earmarked the manufacturing sector as the propeller of the

Malaysian economy, to be championed through the private sector and promotion of export-oriented industries (MP5 1985, 333). MP5 aimed to create an environment that maximised existing and potential linkage and multiplier effects within and between sectors by enhancing the financial and marketing support systems to promote exports and foster technological development. Recommendations of the Industrial Master Plan (IMP) and the Malaysian Industrial Policies Study (MIPS) were referred to when MP5 was conceived (MP5 1985, 333-334).

MIPS was undertaken to rationalise existing industrial policies, particularly tariff policies. A thorough assessment of investment incentives and export promotion policies were evaluated to improve its effectiveness (MP5 1985, 345). The IMP, on the other hand, set-out general industrial development objectives and a framework of strategies and identified subsectors with growth potentials (MP5 1985, 346). The focus was on generating inter and intra sectoral linkages and facilitating the transfer of technology (MP5 1985, 346). IMP identified the following subsectors for the MP5 period – consumer goods; intermediate and investment goods; resource-based manufacturing industries; non-metallic mineral products; rubber processing; metal industry; engineering; chemical and processing industries; electronics; heavy industries; fabricated metal products; transport equipment; chemical and chemical processing industries; and electrical machinery subsector (consumer electronics); selected industrial electronics and non-semiconductor components (MP5 1985, 346).

MP5 promoted an outward-oriented industrialisation policy to expand manufactured exports (MP5 1985, 351). A balanced incentive was pursued to encourage exports and import substitution activities. Market penetration was another strategy; however, this was subjected to restrictive trade policies adopted by industrialised countries (MP5 1985, 351). Also, Malaysia lacked marketing capabilities. To overcome the situation, joint ventures utilising foreign technology and local resources were formalised to tap into established international marketing links. The joint ventures provided marketing expertise for manufactured products and access to R&D (MP5 1985, 351).

Further, MP5 liberalised equity guidelines to attract foreign equity into the export-oriented industries by allowing for a higher percentage of investment ownership by foreign investors proportionate to export output. It was also dependent on the level of technology, potential linkages, the value of investments, location of the factory, local resources used, and value-add (MP5 1985, 352).

6.4.2 Major Institutional and Governance changes

The following is the summary of the institutions which were established and deemed pertinent for the development of the Malaysian economy:

Agency / Body / Organisation	Year of Establishment	Objectives
Pusat Tenaga Atom Tun Dr. Ismail[46] (PUSPATI)	1979 and was to start operations in 1982	To train and research in the application of nuclear technology for agriculture, industry, and medicine (MP4 1981, 121)
Ministry of Science, Technology, and Environment (formerly known as Ministry of Technology, Research, and Local Government)	1973 reorganised in 1976	Coordinate and promote science and technology (MP4 1981, 121)
Coordinating Council for Industrial Transfer of Technology[47]	1982 (MP5 1985, 268)	Formulate strategies for strengthening the process of technology transfer (MP5 1985, 268)
Manpower Development Board (MDB)	1979	Take over the functions of NACIT and the Coordinating Committee of Officials on Employment and Training (MP4 1981, 236)
The Malaysian Administrative Modernization and Manpower Planning Unit (MAMPU)[48]	1977	Coordinating workforce planning, providing consultancy services and introducing new management techniques and innovations to the public service to improve and modernise administrative systems and procedures to increase effectiveness and efficiency (MP4 1981, 118)

Table 24 Institutional and Governance Changes

Source: Compiled by author from the various parts of MP4 (1981)

[46] Atom Nuclear Centre

[47] The responsibility of the Council was transferred to NCSRD in 1985 (MP5 1985, 268)

[48] DAU was renamed Implementation Coordination Development Administrative Unit (ICDAU) and later restructured as MAMPU. Source: https://www.mampu.gov.my/en/corporate-information/history

The following were some of the agencies, institutions or organisations established during the MP4 period:

Name of Organisation	Year of Establishment	Purpose
Centre for Instructor and Advanced Skilled Training (CIAST)	1984	Provide skills upgrading and advanced training to craftsmen in the areas of automotive, machine operation, die making, foundry fabrication, electrical, electronic, and instrumentation skills
National Council for Scientific Research and Development (NCSRD)	Although established in 1975 –"due to certain constraints, NCSRD was not able to fully play its role in the promotion of S&T for national development" (MP5 1985, 262)	Formulate S&T policies and guide R&D towards national goals
Malaysian Institute of Microelectronic Systems (MIMOS)	1985	Conduct basic and applied research in microelectronics, emphasising innovative high technology products. It started by providing Very Large System Integrated (VLSI) design training, the key technology in microelectronic products (MP5 1985, 266).
Nuclear Energy Unit (UTN)	Not available	Train and research in the applications of nuclear science and technology as well as in the supply and use of short-lived radioisotopes in agriculture, food technology, engineering, medicine, and the environment

Table 25 Organisations formed

Source: Compiled by the author based on MP5 (1985)

It is noted that the institutional base to support the development of Science and Technology comprised six statutory and eight departmental research institutes in the various ministries. Research laboratories also existed in universities. MP5 highlighted the lack of direction as most institutions worked in siloes. Further, the national R&D expenditure in 1982 was 0.5 percent of GNP, which was lower compared to South Korea (0.95 percent of its GNP) and Japan (2.78 percent of its GNP) (MP5 1985, 262). The private sector contribution only accounted for 10 percent as opposed to 45 percent and 70 percent for South Korea and Japan, respectively (MP5 1985, 262).

6.4.3 Education and Training

MP4 emphasised expanding and increasing educational efficiency to meet the workforce requirements (MP4 1981, 236). The recommendations contained in the Report by a Cabinet Committee on its review on implementing the Education Policy 1979 became instrumental in introducing various programs. Some of these measures aimed at improving the teaching and learning process, such as class size, student-teacher ratio and curriculum, and the implementation of education support programs such as remedial education and amalgamation of small schools in the rural areas (MP4 1981, 236). Another objective of the education policy was to build a robust and disciplined society by promoting religion, morals, and ethics in school (237).

MP4 intended to replace the system of streaming students into arts, science, technical and vocational fields at the upper secondary level to general education and vocational streaming, following the recommendations of the Cabinet Committee (MP4 1981, 238). Correspondingly, vocational schools were increased to achieve total enrolment at the upper secondary from 4.6 percent in 1980 to 6.3 percent by 1985 (MP4 1981, 238). An added feature of vocational education was introducing a one-year specialised industry-specific skill course designed to train students to acquire the required skill available to students possessing the Malaysian Certificate of Vocational Education (MP4 1981, 238).

Programs for higher education were expected to increase the output of the trained and skilled workforce at the diploma and degree levels (MP4 1981, 239). Therefore, diploma and degree level courses were reviewed to align with national needs. Further, practical training for science, engineering, and technical studies, were stressed (MP4 1981, 239). The output of graduates with a science diploma or degree increased by 60 percent (MP4 1981, 239). Likewise, the intake into courses at the diploma level was to grow to meet the demand for sub-professional positions (MP4 1981, 239). Additionally, post-graduate studies and research was expected to expand to enable inter-disciplinary research and studies (MP4 1981, 239).

MP5 planned to expand and reorient the education system to develop a trained workforce in science, technology, and management (MP5 1985, 497). Additionally, the education policy intended to nurture good qualities, leadership capabilities and strong moral values (MP5 1985, 497). The supply of trained teachers also increased with 23,900 graduating from training colleges – 15,300 deployed to primary schools and 8,600 to lower secondary schools (MP5 1985, 487). These developments were positive and moving towards addressing the skill-shortages experienced.

A new vocational education system for the secondary vocational schools was implemented by including two specialised streams, i.e. vocational and skill. Students sat for mainstream national exams (MP5 1985, 499), whereas the skills stream examination and certification were determined by the NITTCB (MP5 1985, 499).

Intakes in pure sciences and arts, including humanities, biology, and physics, were reduced. The new scope of the intake was to increase the trained workforce in commerce and industry. To encourage workforce development, private sectors were encouraged to set up higher learning institutions (MP5 1985, 501-502). R&D was essential to develop the industrial sector, and higher education institutions were required to establish ties with the private sector and research institutions to increase research output (MP5 1985, 502).

The finding of the Industrial Training Schemes in the Manufacturing Sector completed in 1984 recommended closer cooperation between the public and private sectors in identifying and engaging in industrial training, whilst monitoring the various programs, to achieve industrialisation (MP5 1985, 495).

Further, establishing three new polytechnics, a public university, and several branch campuses increased enrollments (MP5 1985, 488). The breakdown of courses at the degree level provides an understanding of workforce supply for industrial acceleration as envisaged by Malaysian policymakers. Below is the breakdown:

Courses	1980	1985	Increase 1981-85 (%)
Arts	1,664	2,210	32.8
Applied Arts	1,643	3,984	142.5
Pure Sciences	1,235	1,051	-14.9
Applied Sciences	1,200	2,161	80.1
Engineering/technology	615	1,225	99.2
Total	6,357	10,631	67.2

Table 26 Intake into Degree Level Courses, 1980 and 1985

Source: MP5 (1985, 489)

6.4.4 R&D

MP4 mentioned sporadically of R&D 1) through university and industry level collaborative research (MP4 1981, 101, 234, 239), and 2) establishment of the Ministry of Science, Technology, and Environment to coordinate and promote science and technology (MP4 1981, 121).

Industrial research activities were encouraged through collaboration with the private sector, and to that end, the standards institute, SIRIM[49] and nuclear research through PUSPATI[50] were introduced. Further, MP4 alluded to close liaisons with various international scientific organisations and anticipated collaborations in the fields of science and technology through its agencies such as the International Council of Scientific Unions (ICSU), Commonwealth Science Council (CSC), International Atomic Energy Association (IAEA) and the Pacific Science Association (PSA) (MP4 1981, 120-121).

It was not until MP5 that specific planning on Science and Technology (S&T) in a consolidated manner was evident. MP5 aimed to intensify R&D in resource-based industrial development and heavy and high-technology industries (MP5 1985, 261) whilst promoting private sector involvement. It earmarked the manufacturing sector to acquire increased competitiveness, productivity, and efficiency through R&D (MP5 1985, 269). In pursuit of the R&D goals, a National Policy on S&T was introduced for the overall development (MP5 1985, 269). MP5 acknowledged the current fragmented approach to S&T and aimed to centralise planning and coordinate the implementation process to achieve higher R&D productivity (MP5 1985, 269). It planned to comprehensively review the science policy, laws, and institutional arrangements (MP5 1985, 269). As a start, NSCRD was appointed as

[49] Discussed in Chapter 6
[50] Discussed above

the leading science policy organisation to provide adequate intersectoral jurisdiction to plan and manage, whilst an independent mechanism was to be used for evaluation and assessment (MP5 1985, 269).

MP5 approached R&D in a centralised and coordinated manner (MP6 1991, 188) due to constrained workforce and budgets (MP6 1991, 188), resulting in the implementation of the Intensification of Research Priority Areas (IRPA) strategy in 1987 (MP6 1991, 188). This strategy involved prioritising quality R&D activities within the public sector (MP6 1991, 188) through consultations with scientists, academicians, industrialists, and researchers from the public and private sectors (MP6 1991, 188). In the same period, the NCSRD was reconstituted, and a Cabinet Committee on S&T was established (MP6 1991, 188).

MP5 aimed to increase 1) R&D expenditure and 2) private sector involvement (MP5 1985, 269). Initiatives included 1) increasing technological capabilities; 2) training research leaders; 3) strengthening S&T management; and 4) introducing high technology and strategic programs (MP5 1985, 270). Another initiative was the development of indigenous competence in S&T competencies (MP5 1985, 272). The following high-technology areas were prioritised for government support in R&D activities: microelectronics, laser technology, electro-optics, biotechnology, materials technology, manufacturing technology, and software technology (MP5 1985, 273).

6.5 Conclusion

The discussions on the MPs over the period considered in this Chapter (1965-1990) revealed that the economic path in many respects had been fragmented. The apparent trend visible is that most economic policies were straddled with the considerations of NEP, which, if anything, hampered the progress of the innovation system and innovation capability development. Based on the data, the other glaring factor that could be seen at this juncture was a continued shortage of skilled workforce. By the end of 1990, Malaysia had taken leaps in moving to automotive and heavy industries without the expertise or qualified workforce to fulfil the policymakers' agenda. The visible lock-in is the linking of all economic plans to NEP considerations. In the next Chapter, further progress will be traced to have a holistic understanding of the situation.

Chapter 7: Evolution of Malaysia's Innovation System (1991–2016)

7.1 Introduction

This chapter continues the account of Malaysia Plans undertaken in Chapter 6, covering MP6 in 1991 to MP11 in 2016. MP6 was a turning point, with the country transitioning in 1992 from lower-middle-income to higher-middle-income status. From this review of the Malaysia Plans, we can determine the assessment done by the policymakers and the corrective measures taken (if any). It reveals that there is a general lack of skilled workers after 25 years, although there have been structural transitions from resource-based industry to manufacturing and from import substitution to export promotion. This situation is particularly alarming given that the transition to the heavy industry was made during MP4 and MP5. The situation with skills development is highly relevant, given that at the end of MP5, there were no signs of bridging the gap for a skilled or innovative workforce.

In the coming sections of this Chapter, the policies and strategies related to education, skills and R&D will be considered to understand the further progress of the policymakers in racing to achieve their Vision 2020 goal whilst building innovation capability.

7.2 Upper-middle-income-classification

Malaysia transitioned from lower-middle-income to higher middle income in 1992, within 25 years of its first development plan – impressive progress. It was then at a stage where rapid development progress has tapered. It is in an impasse between low-wage producers and highly skilled and fast-paced innovators (Flaaen, Ghani, and Mishra 2013).

7.2.1 Economic Goals Review of MP6

MP6 was launched at the car project's zenith and recovery due to FDI from the mid-1980 recession (Hashim 1992, 195). It coincided with the Second Outline Perspective Plan (OPP2), mapping the decade's development from 1991 (MP6 1991, 3). OPP2 incorporated the National Development Policy (NDP) economic targets, the successor to the NEP, which ended its 20 years lease in 1990 (MP6 1991, 3). In March 1991, Prime Minister Dr Mahathir Mohamad announced Vision 2020 to transform Malaysia into a developed country (Hashim 1992, 195). The vision was defined as follows(Mohamad 1991, 1):

> *… in terms of national unity and social cohesion, in terms of our economy, in terms of social justice, political stability, a system of government, quality of life, social and spiritual values, national pride and confidence … By the year 2020, Malaysia can be a united nation, with a confident Malaysian society, infused by strong moral and ethical values, living in a society that is democratic, liberal and tolerant, caring, economically just and equitable, progressive and prosperous, and in full possession of an* ***economy that is competitive, dynamic, robust and resilient [emphasis added]***

Additionally, the Malaysia Incorporated proposal identified the need for an organisation to act as a go-between to pursue public-private partnerships similar to the Japanese model (Hashim 1992), resulting in the establishment of the Malaysian Business Council (MBC) in 1991 (Campos and Gonzalez 1999, 436). MBC crystallised the Malaysia Inc concept by providing the forum for corporate leaders to exchange views on economic and business policies (Campos and Gonzalez 1999, 436). Oddly, MP6 did not mention the intent to form MBC in its Plan.

The Ministry of International Trade and Industry (MITI)[51] played a crucial part in promoting Vision 2020. Malaysia's MITI, however, differed dramatically from its Japanese namesake. It did not scrutinise any projects as its Japanese counterpart did, starting from the approval, utilisation and eventual transfer of technology to Japanese firms (Rasiah 1996, 85). Nor was it housed by technocratic bureaucrats with the technical ability (Rasiah 1996, 87). As evidenced by the discussion thus far, the possibility of having technically competent personnel questioning the projects was inconceivable, nor was Malaysia in the position to lose its market to neighbouring countries. It would have been ideal for including a technology transfer clause; however, the ability to absorb such technology was not evident at this stage.

[51] Was established as the Ministry of Commerce and Industry in April 1956 and renamed the Ministry of Trade and Industry in 1972. In 1990, it was separated into two ministries, i.e. Ministry of International Trade and Industry (MITI) and Ministry of Domestic Trade and Consumer Affairs (KPDN): https://www.miti.gov.my/index.php/pages/view/1977?mid=27

By 1990, the overall GDP in real terms was 6.7 percent per annum, surpassing the target of 5.0 percent, an impressive growth despite the recession (MP6 1991, 6). MP5 sped up the privatisation exercise to reduce government involvement in economic activities through liberalisation and deregulation programs to improve private investment and competitiveness (MP6 1991, 7). These adjustments aided the economic rebound in 1987, where external demand increased, leading to improved commodity prices and significant increases in leading manufacturers demand, e.g., semiconductors and textiles (MP6 1991, 8).

The Industrial Master Plan (IMP), 1986 -1995, guided the industrial sector's development to improve private investment through focused policy orientation (MP6 1991, 126). The technical assistance via training, feasibility studies, experts, consultants, volunteers, and equipment from bilateral sources accelerated the growth of the manufacturing sector (MP6 1991, 72). The sector's significant contributor was the electrical machinery and apparatus; industrial and other chemicals; non-metallic mineral products; wood and wood products; textiles and clothing; and transport equipment sub-sectors (MP6 1991, 24). MP6 bid to create new sources of growth to strengthen and diversify the industrial base whilst maintaining the importance of electronics, textile, and apparel (MP6 1991, 136). In fulfilling this aim, export-oriented, high value-added, high technology industries supported by indigenous R & D were pursued (MP6 1991, 136). The question remained whether it was realistic for MP6 to adopt modern manufacturing technologies and production processes to increase productivity and skilled labour. The reform agenda was to facilitate a skill delivery system responsive to market and technological demand as identified by the Cabinet Committee on Training Report (MP6 1991, 30).

By 1995, it was forecasted that demand for qualified technicians and engineers, particularly in mechanical and electrical and electronic fields and in electro-mechanical industrial machinery, would be 5.7 percent per annum (MP6 1991, 146). To meet this demand, a levy grant scheme managed by the Human Resource Development Fund (HRDF) was introduced to involve the private sector in training (MP6 1991, 147). In *Table 28,* the critical initiatives[52] introduced by MP6 are set out.

Plan	Strategy
Public Sector R&D	Enhance and integrate national development with priority on: (a) technology adaptation; (b) innovation and utilisation, in line with industrial and export requirements; (c) reorientation of research to meet market needs; (d) raising technology content, efficiency, and productivity of Malaysian industries and services; (e) double the national R&D expenditure as a percentage of GNP by 2000; (f) Incentives such as direct matching grants, soft loans, and preferential credit allocations; (g) The private sector adopts R&D; and (h) Provision of Fiscal and financial incentives and provision of techno-infrastructure to stimulate R&D.

[52] To the extent relevant for this thesis

Education and training programs	a. Upgrading of the school curriculum and teacher training; b. vocational and technical training and higher education; c. upgrade of public sector training institutions; and d. strengthened research and postgraduate programs in institutions of higher learning.
Technical assistance	a. human resource development through the acquisition of technical experts; and b. enhance institutional capacity through training and transfer of technology.
Industrial Sector Program / Strategies	
Industrial Sector development strategies (140)	a. Incentives promoted to encourage self-reliance and the creation of competitive and efficient industries. b. A review of the list of promoted products and activities undertaken c. Review of tariff structure
Recommendations of the Action Plan for Industrial Technology Development (APITD) provided comprehensive guidelines for short, medium, and long-term strategies, were to be implemented (MP6 1991, 141)	a. the intensification of industrial R&D; b. boosting indigenous technological capacity; c. development of an industrial workforce for R&D; d. industry and market-driven R&D centres; and e. R&D funds (MP6 1991, 141). f. critical areas for industrial technology development funding included automated manufacturing; advanced materials; electronic technology; biotechnology; and information technology (MP6 1991, 141).
Manufactured Exports	a. improvement of marketing and information networks, including the rationalisation and modernisation of inefficient industries b. focus on the production of sophisticated high, quality, and value-added products to improve international competitiveness

Development of Small Medium Industries (SMIs)	a. During MP6 initiation, SMIs accounted for 80 percent of manufacturing establishments but contributed less than half of total investment and 1/3 of value-added. b. The small size, inadequate capital, managerial, marketing, and production capability and low use of modern technology have resulted in the lack of inter-industry linkages, low quality, and delivery delays. MP6 aims to improve SMIs by: 1. Establishing Small Scale Division under MITI – to coordinate, rationalise and promote SMIs
Heavy Industries	a. Government intervention where investments are lumpy and with long gestation periods b. Public enterprises will continue in the automotive, petrochemicals, iron and steel, and cement industries.
Malaysia Incorporated	a. Public and private sectors to play complementary roles in industrial development b. Consultative panel to be established under MITI – to achieve more significant coordinated efforts towards export promotion, training, joint R&D, and technological upgrading.

Table 27 Summary of policies, strategies, and programs

Source: Compiled by the author referring to MP6 (1991, 141-151)

As a result of the structural changes during MP6, the manufacturing sector grew exponentially, contributing to one-third of the GDP and three-fourths of merchandise exports (MP7 1996, 5). The Industrial Master Plan assisted in accelerating industrial development by venturing into heavy industries such as petrochemicals, automobiles, iron, and steel

(MP7 1996, 5). Concurrently, private sector involvement was accelerated through the privatisation exercise. However, this exercise transferred public agency inefficiencies into the private sector. It also introduced preferential treatment for those organisations since bureaucrats held top positions.

7.2.2 Economic Goals Review of MP7

On this backdrop, MP7 aimed to upgrade essential skills, capital deepening and technological development. These measures were meant to increase efficiency and competitiveness (MP7 1996, 10). Although private investments increased by 16.6 percent, these were mainly in the oil and gas sector. (MP7 1996, 37). Despite private investment increase, Malaysian industries still imported many intermediate and investment goods, reflecting a shallow industrial base (MP7 1996, 43).

The demand for the workforce was straining the supply given the buoyant economic performance (MP7 1996, 104). Although the number of qualified workforces increased, it was insufficient – in 1985, 55 percent completed secondary education, and 6.3 percent college or university qualified (MP7 1996, 108). Concomitantly, upgrading production technology towards sophisticated and automated processes required 36,350 engineers and 48,800 engineering assistants (MP7 1996, 112). A 12.1 percent professional and technical workforce growth was needed by 2000 (MP7 1996, 123). **Table 28** lists the need between 1990 and 2000 for workforce according to the occupational group.

Occupational Group	1990	1995	2000	Average Annual Growth Rate (%)	
				MP6	MP7
Professional, technical & related workers	586.4 (8.8%)	815.3 (10.3%)	1,097 (12.1%)	6.8	6.1
Administrative & Managerial Workers	163.8 (2.4%)	213.7 (2.7%)	290.1 (3.2%)	5.5	6.3
Clerical & Related workers	652.6 (9.8%)	799.5 (10.1%)	933.8 (10.3%)	4.1	3.2
Sales workers	768.9 (11.5%)	894.4 (11.3%)	1,043.6 (11.5%)	3.1	3.1
Service workers	777.6 (11.6%)	981.5 (12.4%)	1,169.5 (12.9%)	4.8	3.6
Production & Related Workers	1,846 (27.5%)	2,548.8 (32.2%)	3,046.2 (33.6%)	6.7	3.6
Agricultural	1,890.7 (28.3%)	1,662.2 (21.0%)	1,486.9 (16.4%)	-2.5	-2.2
Total	6,686	7,915.4	9,066.2	3.4	2.8

Table 28 Employment by major occupational group

Source: (MP7 1996, 113)

Additionally, a critical demand for R&D personnel existed. In 1995, about 8,300 research scientists were required, making it a ratio of 400 scientists per million population (MP7 1996, 115). To facilitate the demand, student enrolment in engineering and applied sciences at higher learning institutions increased by 35,710 (MP7 1996, 117). The Cabinet Committee on S&T was established to provide policy directions at this stage. Simultaneously, the National Council for Scientific Research and Development (MPKSN) was reconstituted to coordinate and monitor research activities (MP7 1996, 420). R&D agencies were strengthened (existing) or established (new) (MP7 1996, 421). Those established were: 1) National Information Technology Council, 2) Biotechnology Directorate, 3) the Academy of Sciences, 4) the Malaysian Science and Technology Information Centre (MASTIC), 5) the Space Science Studies Centre, 5) Design Council Malaysia, and 6) the National Measurement Centre at the Technology Park Malaysia and the Advanced Materials Research Centre (MP7 1996, 421).

The technological advancement situation proxied by payment for technology acquisition from abroad indicated a growth of 34 percent, at an estimated RM1.0 billion in 1995 (MP7 1996, 426). Most of these were royalties and fees for franchises, international brand names, and payment of licenses of new and improved technology (MP7 1996, 426). These did not cover the import of technology embedded in machinery and equipment and professional charges by foreign personnel (MP7 1996, 426). This finding contradicts the Korean model, which concentrated on operational technology and purchased capital goods or reverse engineering (Lee 2013, 11, Kim 1991, 30, Kim and Yi 1997, 168). Korean policies encouraged foreign technology - capital goods imports, foreign loans, and technology imports (Lee 2013, 12).

To increase total factor productivity (TFP) from 28.7 percent of GDP in 1995 to 41.3 percent by 2000, MP7 encouraged large-scale operations to capitalise on economies of scale, inter-industry linkages, and intermediate and capital goods production to reduce dependence on imports and expand into export markets (MP7 1996, 35). To augment competitiveness, technology advances, strengthened infrastructure, widened global networks, conducive environment for private initiatives, modern and outward-oriented services sector, was planned besides enhancing science and technology, and R&D.

Further, policy and institutional reforms were prioritised to strengthen S&T, enhance R & D, improve management, and improve technology development cooperation between industry, universities, and research institutes to develop technological capability.

Improvement to research agencies facilitated technology transfer and bridged the gap between R&D institutions, academia, and industry. This strategy included reorienting science and technology education to foster creativity and innovativeness to develop high-level scientists, researchers, technologists, and educationists to advance domestic technologies. Information Technology and infrastructure development became the base for the knowledge-based industrial economy – the founding premise of Multimedia Super Corridor (MSC).

The MSC was launched in 1996 to promote the Malaysian government's digital agenda to propel economic development in light of globalisation (Huff 2002, 248). At this time, Malaysia was a second-tier newly industrialised country and criticised by some as too audacious with this effort (Indergaard 2003, 380). MSC was forecasted to launch the Malaysian economy into a "knowledge economy" (Huff 2002, 248), another structural change. The MSC idea was the economic engine needed to pursue the Vision 2020 developmental goals (Huff 2002, 250).

Besides the K-economy, MP7 intended to transform the manufacturing sector into a dynamic, high value-added, capital-intensive, high-technology, and knowledge-intensive industry to achieve productivity and competitiveness (MP7 1996, 284). The targeted average growth rate was 10.7 percent per annum, contributing to a 37.5 percent increase in GDP by 2000 (MP7 1996, 285). However, there were implementation challenges, 1) global competition and 2) skill shortages, raw material costs, and limited domestic capabilities (MP7 1996, 285). Under this strategy, a new IMP was initiated to assess and provide recommendations on the state of selected industrial clusters, i.e., chemicals and chemical products, aerospace, materials, and advanced materials (MP7 1996, 285). Ironically, the identified clusters did not include electrical and electronics. The major policy initiatives for the identified industrial sectors are listed below:

Strategy	Description
Industrial policy reorientation	to undertake large scale production, benefit from economies of scale and export market
Promoting the manufacture of capital and intermediate goods	to reduce reliance on imported components and equipment
Expansion to new growth industries	petrochemical and aerospace industries
Promote Intra and inter-industry linkages	in electrical and electronic products, telecommunications, automotive and iron and steel fabrication industries
Increasing investment in downstream activities of resource-based industries	cocoa and food products, oleochemical, petrochemical, pulp and paper, rubber and wood products
Acquire technology and commercialisation of new and improved technologies	
Implement export target	to increase the market share of Malaysian products
Promoting industry participation in skill training	
Expanding offset arrangements	
SMI development	To induce growth into larger enterprises and be export-oriented
Development of specialised industrial estates	
Maximising the benefits of reverse investment	

Table 29 MP7 Industry initiatives
Source: MP7 (1996, 286)

7.2.3 Economic Goals Review of MP8

The focus increased on small-and-medium scale enterprises (SMEs) to forge linkages in the manufacturing sector, resulting in 18,180 SMEs (MP8 2001, 245). Despite the volume, it contributed to 26.2 percent total value-added of the sector (MP8 2001, 245). In 1999, the Small and Medium Industries Development Corporation (SMIDEC), through the Small and Medium Industry Development Plan (2001-2005), planned SMEs development (MP8 2001, 245). No information was discerned from the Plan on how this institution was monitored and evaluated.

In 2001, MP8, the first phase of the Third Outline Perspective Plan (OPP3) and the National Vision Policy [NVP], was deployed to recover from the 1998 financial crisis and improve competitiveness. Efforts doubled to improve TFP and push knowledge-based industrialisation (MP8 2001, 3). Hence, knowledge-driven policies and strategies to increase output growth, accelerate structural transformation, revitalise the agriculture sector, and strengthen socio-economic stability, were initiated (MP8 2001, 5).

At the dawn of MP8, the manufacturing sector's growth was 8.9 percent per annum, led by the electrical and electronic products sub-sector (MP8 2001, 42, 250). However, the expectation was for the sector to shift into higher technology and value-added consumer and industrial products (MP8 2001, 42). Industries identified to increase contributions were petrochemical, pharmaceutical, furniture, food, handicraft, and services. MP8 aimed to expand and grow the manufacturing sector by 8.9 percent, contributing to a 35.8 percent share of GDP by 2005 (MP8 2001, 259).

The privatisation strategy continued in MP8 to enhance Bumiputera participation and sustainability of privatised firms (MP8 2001, 183). The Privatisation Action Plan, a two-year rolling plan, and the National Vision Policy (NVP) guided this exercise (MP8 2001, 198). Ergo, regulatory authorities were restructured into influential sector-based regulatory bodies (MP8 2001, 199).

MP8, together with IMP 2, promoted industrial clusters to address the factors of a critical mass of entrepreneurial firms, networking capabilities, technology management, technology transition, and skill formation (MP8 2001, 252). **Table 30** identifies the focussed industries:

Industry	Strategies
Electrical and Electronics	a. Shift to higher value-added activities b. Production of advanced products both for semiconductor and consumer electronic goods c. Promote R&D
Automotive	a. Efficiency and competitiveness of the automotive cluster to be improved b. Develop capabilities and production technologies and R&D c. Locally produced components and parts to be upgraded
Aerospace	a. Early-stage and, therefore, capabilities needed development.
Resource-based	a. To enhance the competitiveness of palm oil-based products.
Chemical	a. Petroleum products, petrochemicals, inorganic chemicals, oleochemicals, and industrial gases
Pharmaceuticals	a. Producers concentrated on generic drugs

Table 30 Manufacturing Sector Strategies
Source: (MP8 2001, 252-256)

7.2.4 Economic Goals Review of MP9

In 1996, knowledge-based service industries expanded with MSC and the National Biotechnology Policy in 2005 – shifted focus from manufacturing to services (MP9 2006, 6). Accordingly, the shift towards knowledge and innovation-based growth increased the

GERD at an average of 9.4 percent per annum from RM1.1 billion in 1990 to RM4.3 billion in 2005. The ratio of GERD to GDP improved from 0.4 percent in 1990 to 0.9 percent in 2005. Simultaneously, the number of researchers per 10,000 population increased from 7.0 in 1990[53] to 25 in 2005, though trailing from the OECD average of 61 (MP9 2006, 8). Though the increase in the number of researchers per 10,000 population was commendable but was way below the target. Further, R & D commercialisation rates were low, and patents granted to Malaysian residents crawled from 20 in 1990 to 37 in 2005 (MP9 2006, 8).

The Malaysian economy's preparedness to gravitate towards a knowledge-based economy was gauged through an index introduced to monitor the select factors required to drive a k-economy, e.g., computer infrastructure, info-structure, education and training, and R&D (MP9 2006, 46). In all the identified areas, the KDI increased by 591 points from 2,413 in 2000 to 3,004 in 2005 (MP9 2006, 47), signalling a significant improvement in computer infrastructure, closely followed by R&D and technology (MP9 2006, 47). Similarly, an assessment of knowledge readiness based on the level of knowledge content undertaken across ten manufacturing and eight services industries found that all the industries had built a certain level of knowledge competency and capability and embarked on some form of knowledge acquisition, generation, and sharing activities. The information technology services, chemical, telecommunications, tertiary education, and financial services industries exhibited better knowledge readiness (MP9 2006, 48).

[53] As discussed above, the figure given in MP9 is divergent from that mentioned in MP8 p96.

A 6.7 percent per annum contributing to 31.8 percent share to GDP projected expansion of the manufacturing sector was aimed under MP9 through the operationalisation of the Third Industrial Master Plan (IMP3) [2006-2020] (MP9 2006, 66). The sector focused on high technology industries, especially automotive, biotechnology, and electrical and electronics (MP9 2006, 116). The strategy was to forge and intensify strategic integration with foreign affiliates through joint ventures, mergers, and acquisitions in high value-added and high technology industrial activities and related services (MP9 2006, 116). The electronics subsector was expected to recover in the first half of MP9 following increased world demand for integrated circuits, optoelectronics, discrete electronic sensors, and wireless products. This subsector's projected growth was an average of 7.7 percent per annum (MP9 2006, 1200).

Given the aim of being a knowledge-based economy, MP9[54] pursued the following:

Key thrusts	Description
Moving up the value chain	a. To shift to a human-capital driven economy by: 1. Increasing productivity, competitiveness, and value-added in agriculture, manufacturing, and service sectors. 2. Generate new sources of wealth in technology, e.g., ICT and biotechnology 3. Upgrade employment in high-technology and knowledge-intensive activities 4. Led by the private sector and increasing private sector investment. 5. Inculcating a culture of high performance and excellence

[54] Only three out of the five thrusts have been discussed here.

	6. Expanding the market for Malaysian products and services
Increase capacity for knowledge and innovation and nurture *first-class mentality*	a. Knowledge, innovation, and values 1. Improve the education system 2. Produce university of international standing 3. Create avenues for skills development and training 4. Cater to an environment and innovation system that encourages R&D and commercialisation
Strengthen the institutional and implementation capacity	a. In furtherance to the National Mission to have a well-functioning administrative and implementation machinery 1. Improving public service through governance 2. Addressing corruption 3. Enhancing corporate governance and improving legal and regulatory frameworks

Table 31 MP9 Key Themes
Source: MP9 (2006)

Next, the automotive industry's liberalisation was expected to stimulate motor vehicles and components for domestic and regional markets—the National Automotive Policy 2006 geared at making the automotive sector competitive. It aimed to achieve economies of scale, improve cost-effectiveness, enhance industrial linkages, and increase exports. It sought to shift the automotive industry into higher value-added products and services. The measures were developing existing and new automotive clusters, building technical, engineering, R & D capabilities, and establishing the Automotive Development Fund (MP9 2006, 121).

MP9 also implemented the National Biotechnology Policy to develop agricultural biotechnology, healthcare-related biotechnology, industrial biotechnology, and bioinformatics (MP9 2006, 161) and targeted 400 biotechnology-related companies set up by 2010 (MP9 2006, 162).

The following policies were introduced during MP9:

Policy	Year Established	Description
National Mission Policy	2005	Framework aimed at obtaining greater performance and impact (MP9 2006, 23)
The National Biotechnology Policy	2005	To improve the regulatory framework for biotechnology investments; increase access to funding; improve R&D commercialisation; increase research workers, and attract a foreign partner for R&D and technology licensing and product development (MP9 2006, 27)
National Automotive Policy	2006	To develop a resilient and vibrant automotive and components industry. It is intended to enable industry participants to achieve economies of scale, improve cost-effectiveness, enhance industrial linkages, and be export-focused (MP9 2006, 121)
National Space Policy	To be formulated	Provide strategic directions to enhance the development of the local aerospace industry and identify the development of potential investment opportunities (MP9 2006, 122)

Table 32 Policies Introduced during MP9

Source: MP9 (2006)

7.2.5 Economic Goals Review of MP10

By the end of MP9, assessments revealed that the national innovation agenda failed in achieving the intended outcome. A declining capability for knowledge generation, proxied through researchers per 10,000, marginally declined from 21.3 in 2004 to 20.3 in 2008 (MP10 2011, 80). At MP10, Malaysia was no longer a low-cost imitator nor a high value-add innovator. Hence, strategies were needed to bring Malaysia up to speed to achieve its economic goal (MP10 2011, 3). Some persistent challenges were the poor performance of private investments - reduced from 25 percent in the 1990s to 10 percent of GDP in 2000. Private investment is needed to grow exponentially if Vision 2020 is to be achieved (MP10 2011, 4). The other continual challenge was a lack of talented human capital – reducing labour productivity (MP10 2011, 4).

MP10 drove a paradigm shift in economic strategy and public policy by conceiving the 10 Big Ideas Concept (MP10 2011, 7). The following were the ten big ideas:

1.	**Internally driven, externally aware.**
2.	**Leveraging on our diversity internationally**
3.	**Transforming to high-income through specialisation**
4.	**Unleashing productivity-led growth and innovation**
5.	**Nurturing, attracting, and retaining top talent**
6.	**Ensuring equality of opportunities and safeguarding the vulnerable**
7.	**Concentrated growth, inclusive development**
8.	**Supporting effective and smart partnerships**
9.	**Valuing our environmental endowments**
10.	**Government as a competitive corporation**

Table 33 10 big ideas

Source: MP10 (2011, 8)

Of the ideas, those relevant for this thesis are transforming to high-income through specialisation; unleashing productivity-led growth and innovation; and nurturing, attracting, and retaining top talent. Accordingly, competitiveness was highlighted, and a key initiative was the implementation of Competition Law, removal of distortionary price controls, and liberalisation (MP10 2011, 9). These measures aimed to improve the ease of doing business in Malaysia, encouraging private investments (MP10 2011, 10). MP10 intended to support new and competitive growth sectors by providing a policy framework, developing human capital, enabling infrastructure, and supporting industrial clusters.

MP10 appraised the progress of the National Mission carried out in MP9 (MP10 2011, 44). Only thrust one and two is considered for this thesis:

Thrust	**Assessment**
Moving the economy up the value chain	a. During MP9, investment was made in renewable energy and high-end electronic products, machinery, equipment, and medical devices. Also, there were visible improvements in biotechnology projects (MP10 2011, 44). b. Broadband infrastructure penetration increased from 2 percent in 2005 to 32 percent in 2009 (MP10 2011, 45) c. Expanding and improving the transportation network (MP10 2011, 45) d. Reliable and quality supply of energy (MP10 2011, 45) e. Foreign Investment Committee guidelines removed – removing equity conditions imposed on non-strategic sectors (MP10 2011, 46)

Raising the capacity for knowledge and innovation and nurturing the first-class mentality.	a. Enrolment at both elementary and high-school increased (MP10 2011, 46) b. Enrolment in higher education rose from 649,000 in 2005 o 949,000 in 2009 (MP10 2011, 46) c. Intake in public technical and vocational training institutes rose by 1.5 percent per annum (MP10 2011, 47)

Table 34 Assessment of two MP9 Missions
Source: MP10 (2011)

Improving public efficiency was essential in implementing the Government Transformation Program (GTP) to streamline government processes and reduce the cost of doing business in Malaysia (MP10 2011, 57). The public-private partnership (PPP) was a significant venture to promote economic growth through private sector participation (MP10 2011, 57). The 1Malaysia concept built upon the GTP and New Economic Model (NEM), providing new policies and strategies (MP10 2011, 64).

The following strategic shifts were undertaken during MP10:

Private sector-led economy	Modernising business regulation and liberalising the services sector
Innovation-led growth	Creating a supporting innovation ecosystem
Rationalising the role of Government in business	Increasing privatisation and public-private partnership
Developing SMEs	Reduction of regulatory costs
Compering globally	Supporting Malaysian firms in global markets
World-class infrastructure	Increasing broadband penetration and other physical infrastructure
Key growth engine	Developing National Key Economic Areas (NKEAs)

Table 35 Summary of strategic shifts
Source: MP10 (2011, 69-70)

As part of the innovation agenda, the bankruptcy laws, incubator program, and knowledge SMEs (K-SMEs) were reviewed (MP10 2011, 80). K-SMEs played a pivotal role in promoting innovation and accessibility of financing schemes, improving research and innovation and specialised skills training (MP10 2011, 82). It is a process of integrating and coordinating systematically the *acquisition, creation and deployment of knowledge, experience and expertise* in SMEs (Bakar, Mahmood, and Ismail 2015, 207). MP10 aimed for private sector-driven economy development.

MP10 focused on National Key Economic Areas (NKEAS), which was essentially a small number of sectors to obtain comparative advantage (MP10 2011, 122). The initial sectors were: 1) oil and gas, 2) palm oil, 3) financial sector, 4) wholesale and retail, 5) tourism, 6) ICT, 7) education, 8) electrical and electronics, 9) business services, 10) private healthcare, 11) agriculture, 12) greater Kuala Lumpur (MP10 2011, 122). Measures to be undertaken according to sectors is as per **Table 36.**

Sector	Initiatives
Oil and Gas	1. Increase international market access 2. Enhance both technical and management skills in partnership with industry 3. Enhance linkages to downstream industries 4. Expand logistics and maritime business activities 5. Strengthen oil and gas-related professional services (MP10 2011, 123)
Palm Oil	1. Promote Malaysia as a global hub 2. Develop a palm oil industrial cluster to promote downstream activities 3. Encourage good agriculture practices 4. Centralise procurement of agricultural inputs (MP10 2011, 124)
ICT	1. Aggressive promotion of ICT in all industries

	2. A National Creative Industry Policy and National Digital Terrestrial Television Broadcasting project proposed 3. Education and training reoriented to meet human resource requirements in the sector (MP10 2011, 129)
Electrical and Electronics	1. Develop centres of engineering excellence through collaboration with industry and academia 2. Promote state skills training centres 3. Strengthen incubators 4. Focused incentives on strategic segments (MP10 2011, 131)

Table 36 Summary of key initiatives in key NKRA
Source: MP10 (2011, 44-50)

7.2.6 Economic Goals Review of MP11

As the final leg to achieving Vision 2020, MP11 was significant and pivotal (Reuter 2015, Oh 2015). Productivity was the underlying theme of MP11 (Azhar 2015). However, it was up against a weak ringgit, global oil price collapse, impacting Malaysia's revenues, and the massive RM42 billion debt accumulated by the 1Malaysia Development Bhd (1MDB) (MalaysiaKini 2015). The 1MDB was set up in 2009, a state-owned investment vehicle to turn Malaysia into development and financial hub (Healy 2016, Case 2017, 634). However, the 1MDB scandal rocked the world when the Department of Justice (DoJ) claimed at the end of an investigation that some US$1 billion had been syphoned by a *Malaysia Official 1* widely referred to the then Prime Minister, Najib Razak (Healy 2016). This was very quickly exacerbated by investigations in seven foreign jurisdictions involving criminal mismanagement, misconduct in public office, forgery, bribery, embezzlement and fraud (Case 2017, 633-34).

Amidst 1MDB chaos, MP11 was rolled out. It prioritised human capital development and focused on four key areas, 1) improving labour market efficiency to accelerate economic growth, 2) transforming technical vocational education and training, 3) improving education quality, and 4) inculcating life-long learning values (Reuter 2015). Although the human capital development focus was welcome, much scepticism was abounding on whether human capital could be improved within five years. According to commentators, human capital has been Malaysia's long-standing weak point (Oh 2015). As it stands, Malaysia's productivity against its peers Thailand and Indonesia rates highly but falls short when compared to Korea and Singapore. Further, Malaysia's labour productivity in 2015 stood at US$24,934 compared to US$46,097 for Korea (Azhar 2015). MP11 targeted productivity growth at 3.7 percent per annum to hit RM92,300 per person by the end of 2020 (Azhar 2015).

The Malaysian National Development Strategy (MyNDS) focussed on delivering high impact capital and people economies. It had six strategic thrusts and six game-changers to achieve Vision 2020. The strategic thrusts were 1) enhancing inclusiveness, 2) improving wellbeing, 3) accelerating human capital development, 4) green growth, 5) infrastructure development, and 6) re-engineering economic growth (MP11 2016, 1-1). Accelerating human capital development is relevant for this thesis of the six thrusts.

To improve the labour conditions and growth, several legislative reforms were undertaken, i.e., Employment Act, 1955, Industrial Relations Act 1967, and Trade Unions Act 1959, which were amended to keep pace with the labour market (MP11 2016, 5-5). MP11 adopted a multidimensional approach to balance economic growth, wealth distribution, and national wellbeing (MP11 2016, 2-12). This multidimensional goal translated to *inter alia* 1) a targeted GDP growth of 5 to 6 percent per annum, 2) labour productivity-increasing from RM77,100 in 2015 to RM92,300 in 2020, and 3) GNI per capita of RM54,100 (US$15,000) by 2020 (MP11 2016, 2-14).

A Productivity Blueprint was conceived to strengthen the governance and institutional mechanism for implementing productivity strategies and establishing a national productivity portal (MP11 2016, 2-15). The public sector productivity was by adopting key performance indicators (KPIs), accelerated regulatory reforms, and rationalising government institutions (MP11 2016, 2-15). Additionally, the up-skilling and re-skilling agenda rehashed the increased industry-academia collaboration at the research front to stimulate innovation (MP11 2016, 2-15). **Table 37** shows the projected productivity target between 2010-2020.

Sector	RM '000, in 2010 prices							Growth, % p.a.	
	Actual					Estimate	Target	Estimate Tenth Plan	Target Eleventh Plan
	2010	2011	2012	2013	2014	2015	2020	2011-2015	2016-2020
Agriculture	51.7	55.3	55.8	56.4	57.5	57.7	68.8	2.2	3.6
Mining and quarrying	1,089	1,064	1,076	1,083	1,114	1,147	1,210	1.1	1.1
Manufacturing	94.4	94.4	94.4	94.8	95.5	98.8	112.1	0.9	2.6
Construction	24.7	25.8	30.0	32.2	35.7	39.1	61.9	9.6	9.6
Services	59.3	60.8	62.4	63.8	66.4	68.1	83.4	2.8	4.1
Total	**68.7**	**69.9**	**71.4**	**72.5**	**75.0**	**77.1**	**92.3**	**2.3**	**3.7**

Notes: Based on GDP in 2010 prices
Source: Economic Planning Unit and Department of Statistics Malaysia

Table 37 Labour productivity, 2010-2020

Source: (MP11 2016, 2-17)

The Malaysian policymakers intended the shift to be focused and dispersed to all levels, i.e., national, industry, and enterprise. This venture is spearheaded by industry champions and associations, supported by the Malaysian government through the National Productivity Council (MP11 2016, 2-18). The focus sectors were services, manufacturing, agriculture, construction, and SMEs. However, for this thesis, the sector discussed in length was manufacturing.

The following are the initiatives for each of the sectors identified above.

Sector	Initiatives
Services	1. Create a knowledge-intensive services sub-sector, particularly ICT 2. Strengthen the governance and collaboration between the various stakeholders 3. Improve investment management incentives 4. Expand to modern services (MP11 2016, 8-16)
Manufacturing	1. Transition to complex and diverse products

	2. Improve productivity through automation 3. Stimulate innovation-led growth 4. Improve growth enablers 5. Be internationally competitive (MP11 2016, 8-21)
Agriculture	1. Improve productivity and income 2. Promote training for agropreneur 3. Strengthen institutional support 4. Build capacity in agricultural cooperatives and association 5. Improve market access (MP11 2016, 8-24)
SMEs	1. Improve productivity through automation and innovation 2. Improve human capital within SME 3. Improve ease of doing business indicator 4. Create demand for SME products and services 5. Create homegrown champions 6. Develop SME in East Malaysia (MP11 2016, 8-29)

Table 38 MP11 Initiatives

Source:MP11 (2016)

7.3 Major Institutional and Governance Changes

In this part, the institutions and governance changes from 1991 to 2016 contributing to Malaysia's development of innovation capability is detailed.

Organisation / Agency / Firm	Established	Purpose
Malaysian Business Council	1991	Provide corporate leaders with a forum to exchange economic and business policies views.
Human Resource Development Fund	1992	Stimulate private sector involvement in workers' training and retraining.

Cabinet Committee on S&T	1991-1995[55]	To consider Science, Technology, and Innovation related legislation and programs (OECD 2016, 152)

Table 39 Major Institutions Established, MP6

Source: Compiled by the researchers from the various part of MP6

The following were some of the institutions introduced in MP7

Agency / Firm / Organisation	Year of Establishment	Functions
Malaysia External Trade Development Corporation (MATRADE)	1993	Provide market information and support to Malaysian exporters (MP7 1996, 267)
Malaysian Trade and Distribution Centre		Provide marketing base to sell and distribute Malaysian products to European buyers (MP7 1996, 267)
General Trading Companies (GTCs)		Enhance export of Malaysian products and services to countries of South, conduct feasibility studies, fact-finding, advertising, and setting up distribution centres (MP7 1996, 267)
Export-Import Bank (EXIM)		To provide support in strategic marketing and export financing (MP7 1996, 287)
Industrial Adjustment Allowance / Industrial Adjustment Fund (IAF) **(consolidated into Domestic Investment Fund (DIF))**	1991 1995	To assist industries in undergoing structural adjustments to increase efficiency and competitiveness, particularly in wood, textile machinery and engineering industries (MP7 1996, 276)
Small and Medium Scale Industries Development Corporation (SMIDEC)	To be established	Provide leadership to formulate focused development programs (MP7 1996, 296)
Higher Education Council		Public and private sector to coordinate in planning and development of tertiary education (MP7 1996, 333)

[55] Exact year is unavailable

Department of Higher Education	1995	To support the council (MP7 1996, 333)
Intellectual Property Protection		Review existing intellectual property legislation and formulate new ones to enhance protection to fulfil the commitments under Trade-Related Intellectual Property Rights Agreement

Table 40 The various organisations or changes proposed.

Source: Compiled by author from the various parts of MP7 (1996)

The following bodies were established to encourage economic growth:

Firm / Agency/Organisation	Year	Description
Small and Medium Industries Development Corporation (SMIDEC)	1996	Provide leadership in planning and overall coordination to promote indigenous SMEs to be efficient and competitive to produce high-value-added and quality products and services (MP8 2001, 245)
Malaysian Technology Development Corporation	1992	Established during MP6 was in MP7 tasked to overlook the Commercialisation of Research and Development Fund and Technology Acquisition Fund (launched in 1997)(MP8 2001, 245)
Ministry of Science, Technology, and Environment (MOSTE)	1973 reorganised in 1976[56]	Responsibility expanded to undertake the coordination of research resources and budgetary allocations (MP8 2001, 342)
Malaysia-MIT Biotechnology Partnership Program	1999	Build the foundation for the development of a sustainable biotechnology industry (MP8 2001, 344)

[56] Discussed in Chapter 6

A National Space Agency	To be formed	Consolidates the Malaysian Centre for Remote Sensing and Space Science Studies Division (BAKSA) of MOSTE. It will be responsible for formulating and implementing the National Space Policy and Program (MP8 2001, 358)

Table 41 Major institutions set up

Source: Compiled by the researcher from the various parts of MP8 (2001)

Tables 42 and 43 list institutions formed and laws legislated between 2006 and 2011.

Agency/Firm/Institution/Organisation	Year Established	Functions
A high-level Implementation Committee	To be established	To monitor the overall performance and effectiveness of the programs and projects.
Malaysian Qualification Framework (MQF)	To be formed (2006)	charged with education quality improvement by imposing qualifications and delivery standards
National SME Development Council		To provide a strategic framework for focused and coordinated inter-agency efforts on SME development.
Biosafety Bill		
Access and Benefit Sharing (ABS) Bill		To ensure fair and equitable sharing of benefits from the use of Malaysia's biological resources and protect against biopiracy.
Intellectual Property Corporation of Malaysia (MyIPO)	2003	To strengthen the patent registration and management system (MP9 2006, 268)
The National Innovation Council	2004	Formulate policies and essential strategies to stimulate innovation

Table 42 Organisations formed or proposed in MP9.

Source: MP9 (2006)

Institution / Regulatory / Governance	Year	Descriptions
A rating system for Malaysian Higher Education Institutions	2007	Enhance the quality and promote best practices amongst public universities
The National Skills Development Act	2006	to facilitate the enforcement of accreditation procedures, which resulted in the accreditation
GTP	2010	To transform the Government to be effective in the delivery of its services.
NEM		Lays the Strategic Reform Initiative (SRIs) (MP10 2011, 65)
PEMUDAH	2007	Special task force to facilitate business
Competition Law 2010 Competition Commission and Competition Appeal tribunal	2010	Ensure smooth and effective implementation of the legislation,
Innovation Malaysia	To be established	Unit to oversee and coordinate innovation initiatives to improve the quality of R&D and its contribution to IP generation (MP10 2011, 141-142)
MIDA		Expanding the role of becoming the central investment promotion agency for manufacturing and services with decision-making authority (MP10 2011, 141)

Table 43 The various organisations, regulations, and governance during MP10 or prior as identified by the Plan
Source: The researcher by reference to MP10 (2011)

MP10 identified the potential expansion of scope and overlapped between the institutions and stressed institutional structure reforms (MP10 2011, 85). **Figure 21** provides the institutional structure supporting innovation and R&D:

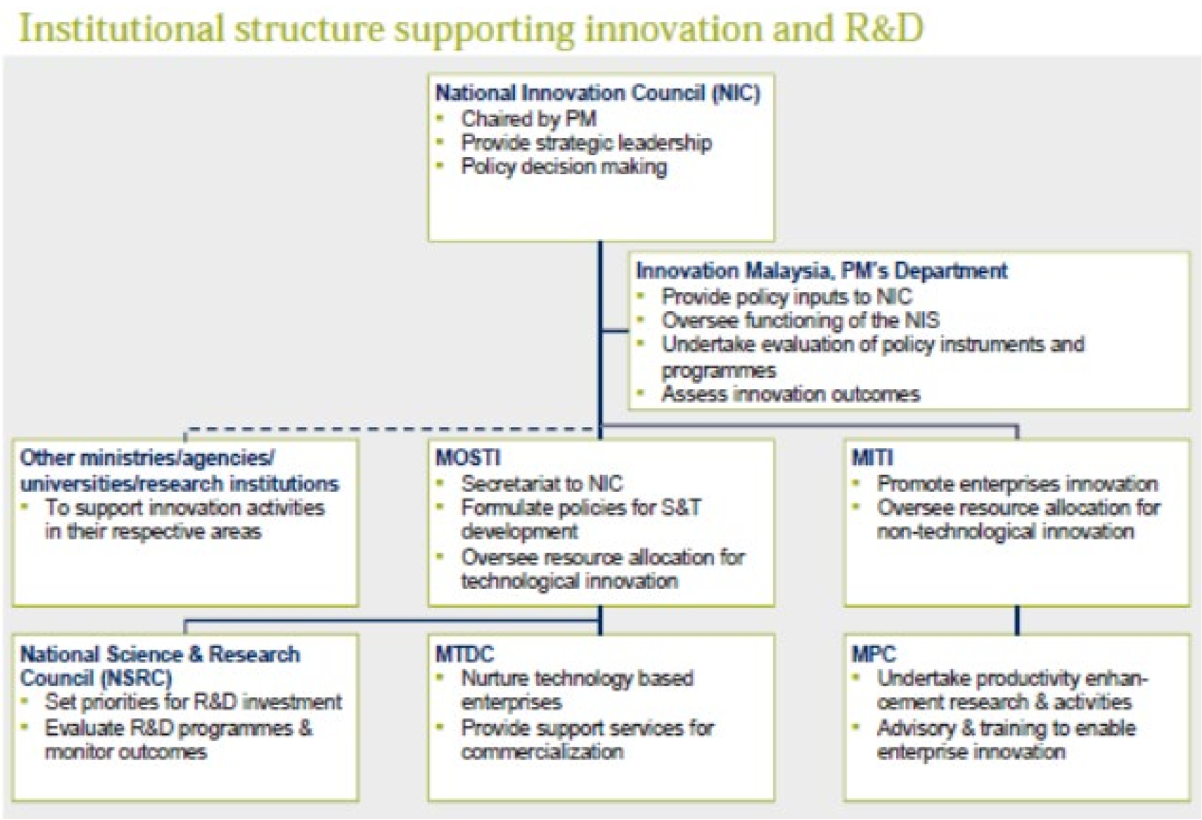


Figure 21 Institutional Structure Supporting Innovation, MP10

Source: MP10 (2011, 85)

MP10 was also the impetus for creating other institutions and regulations, as outlined in **Table 44**.

Institution / Regulatory / Governance	Year	Descriptions
Malaysia Productivity Corporation (previously known as National Productivity Council)	1966 2008	
Malaysia Education Blueprint	2013	
Malaysia Education Blueprint	2015	
Talent Roadmap	2020	Strategies to attract top talents
Talent Corporation	2011	To attract and retain the talent required for an advanced nation.
Institute of Labour Market Information and Analysis	2012	To improve labour market information analyses

(formerly National Institute of Human Resources) – under the Ministry of Human Resources		
Labour Market Information Data Warehouse	2013	To share critical information such as workforce supply and demand projections by economic sectors and development corridors under one roof.
National Human Capital Development Council	To be established	Council to be composed of ministers, implementors from relevant agencies, major private sector players, and industry representatives (MP11 2016, 5-15)
iDana Portal	2014	To operate as a centralised registry for R&D&C&I information to encourage resource sharing (MP11 2016, 8-31)
Research Management Agency (RMA)	To restructure an existing agency	Strengthen the institutional mechanism to manage public R&D&C&I initiatives (MP11 2016, 8-31)

Table 44 Institutional and Governance Changes
Source: MP11 (2016)

The relevant institutions will be identified and discussed in Chapter 8.

7.4 Education and Training

The increased educational facilities in MP5 led to improved quality and delivery of education through the New Primary School Curriculum. In 1989, the Integrated Secondary School Curriculum aimed to produce a balanced student with the knowledge, skills, and moral and ethical values (MP6 1991, 158). Further, vocational and technical education was restructured to appeal (MP6 1991, 158). MP6, like its predecessors, aimed for accessible education for all lower socio-economic groups and improved quality and training. (MP6 1991, 170). Developing responsible citizens with strong moral and ethical values has always been the core of education policy (MP6 1991, 157).

By 1995, expanded vocational education facilities increased enrolment by 8 percent of total upper secondary enrolments (MP6 1991, 173). The focus fields were electronics and automotive, general machining, technical and mechanical drawing and furniture making and designing (MP6 1991, 174). At a higher level, new polytechnics were established to offer diploma level courses in engineering, e.g. electronic communications, computer technology and textile engineering (MP6 1991, 174), while expanding the capacity of existing polytechnics. Additionally, R&D programs in universities were prioritised (MP6 1991, 175-6).

A shortage of skilled and trained workforce pushed for public skill training institutions. The Cabinet Committee Report on Training identified that existing institutes lacked effectiveness which needed improvement (MP6 1991, 177). It recommended 13 broad policy directions encompassing 50 policy measures which essentially sought to improve the responsiveness of public training to market demand; expand the private sector's role and strengthen the linkages between training and technological changes; enable institutions to react and adjust to changes on the types and levels of skills required by the industry; provide a platform for effective feedback mechanisms and labour market monitoring system, and improve education and training delivery system to equip graduates with relevant skills demanded by the industry (MP6 1991, 177).

The focus on education and skill training continued through MP7 to address highly qualified and skilled workforce supply issues (MP7 1996, 303). Aside from the supply objective, MP7 preserved the production of disciplined citizens with high moral values and good work ethics agenda (MP7 1996, 321). **Table 45** summarises specific initiatives for tertiary education.

Initiative	Description
Increased capacity	To meet local demand for higher education and as an export industry.
Improved quality and relevance	To match the workforce requirements.
Increase enrolment at the first-degree level	Those within the age group of 19-24
Increase capacity in specific enrolments	Science, engineering, and technical-related courses to produce a workforce with science and technical knowledge
Increase in postgraduate studies	To increase enrolments
Increase capacity and capability	To undertake R&D in relevant industrial and services sectors.
Increase private sector participation	Supplement government efforts

Table 45 Initiatives for Tertiary Education, 1996 – 2000
Source: MP7 (1996, 328-9)

MP7 undertook the following institutional restructuring:

1. Amended the *University and University Colleges Act*,1971 in 1995 to allow the corporatisation of public institutions of higher learning, giving autonomy to manage and operate dynamically (MP7 1996, 334).
2. Establish the Higher Education Council to coordinate the public and private sectors (MP7 1996, 334).

3. The enactment of the *Private Higher Educational Institution Act*, 1996 enabled the private sector to establish degree-granting institutions and encourage foreign universities to set up branch campuses (MP7 1996, 337).
4. Other languages, mainly English, were given prominence aside from national language competency (MP7 1996, 334).

Local institutions of higher learning were required to operate as centres of R&D excellence and consultancy to develop expertise in information technology, advanced manufacturing, biotechnology, aerospace, energy, environmental-related technology, and communication technology (MP7 1996, 332). In this period, enrolment increased particularly for medicine and dentistry, engineering, architecture, survey, and town planning, corresponding to achieving a 60:40 ratio of science to arts enrolment (MP8 2001, 104). Meanwhile, the output of skills training institutes increased with 187,440 skilled and semi-skilled workforces. This output was at an average annual growth of 9.8 percent (MP8 2001, 107).

Following those reforms, MP8 reoriented to acquire a higher level of *explicit knowledge, thinking, and entrepreneurial skills* through the improved curriculum (MP8 2001, 112). The private sector's role in education was anticipated to meet the increased demand in complex areas such as biotechnology and bioinformatics (MP8 2001, 112). Again, visibly MP8 promoted positive values from a young through incorporating civics in moral or religious education (MP8 2001, 117). The critical initiatives under MP8 are listed under **Table 46**:

Strategy	Description
Increased Access to quality education and training	a. The private sector was encouraged to initiate new campuses to cater to increased demand b. Loans made available to students c. Skills Development Fund intended to accelerate and extend training
Improve the quality of education and training	a. Subjects are to be taught using computer-based resources and multimedia technology. b. Ensure NVTC strengthened and supply of qualified instructors are expanded
Optimised local labour use	a. Increase the participation of women in the workforce b. Amendments made to *Employment Act 1955* to cater for different work arrangements c. The retirement age extended to 56
Increase the supply of S&T workforce	a. Expand training to achieve the 60:40 ratio of science to arts b. Encourage postgraduate and post-doctoral studies in science – the introduction of the Science and Technology Human Resources Fund c. Industrial policies to be integrated with education and training policies d. The ratio of R&D scientists and technologists target 30 /10,000 in the workforce by 2005.

Table 46 Key Strategies in Education and Training

Source: Compiled by the researcher based on MP8 (2001, 112-118)

The conversion of secondary vocational schools (SVS) to secondary technical schools (STS) expanded the technical stream while maintaining the vocational and skill streams for the low achievers (MP8 2001, 102). This action's net result was students with a strong foundation in technical and science subjects with employable skills (MP8 2001, 102). Of the 59,500 students enrolled in STS in 2000, 50 percent were vocational and 10 percent in the skill stream (MP8 2001, 102).

The success of the National Mission under MP9 was dependent on the workforce quality. Hence, human capital development was holistically approached where it involved knowledge and skills or intellectual capital acquisition and entrepreneurial capabilities (MP9 2006, 237). Simultaneously, MP9 aimed to strengthen the overall mindset, culture, values, and social institutions to align with the development plan. Thus, moral and ethical foundations were relevant to enhancing mindset and attitude toward excellence and performance (MP9 2006, 4).

The capacity and capability of public training institutes were strengthened to meet the knowledge development needs of public sector employees (MP9 2006, 253). At the same time, private training institutions provided management and specialised training for highly competent managers to compete in the global market (MP9 2006, 253). The Institut Keusahawan Negara[57] coordinated entrepreneurial training programs (MP9 2006, 254).

A quality rating system for higher learning institutions was introduced to maintain quality and excellence. Ergo, the Malaysian Qualifications Framework (MQF) was introduced and monitored through the Malaysian Qualifications Agency (MP9 2006, 257). One of the aims was, by 2010, 60 percent of academic staff had a doctorate qualification. The research and

[57] will undertake entrepreneurial training National Entrepreneurs Institute

innovation capability of local higher education institutions required strengthening to reach a critical mass of research scientists and engineers intended to meet the target ratio of 50 per 10,000 labour by 2010 (MP9 2006, 258)

The success of the innovation agenda was dependent on the education system's ability to nurture a creative and analytical human capital (MP10 2011, 81). A high-income workforce displays 1) higher education qualifications promoting knowledge generation and innovation, 2) high skill levels in both technical and professional fields, 3) strong levels of productivity (MP10 2011, 192). The achievement of Malaysia in the Trends in International Mathematics and Science Study (TIMSS), which benchmarks students internationally, revealed that Malaysian student performance was deteriorating from 5 and 7 percent respectively for mathematics and science in 2003, to a 20 percent failure rates for both the subjects in 2007 (MP10 2011, 193).

Additionally, it was concerning that the Malaysian workforce remained relatively unskilled, with 77 percent only having achieved basic qualifications (MP10 2011, 193). The Malaysian policymakers faced an acute talent shortage. This shortage has been observed in this narrative from as early as 1981. It raises a fundamental question on why this difficulty arises, given that countries that started after Malaysia perform well in this aspect. MP10 aimed at an integrated talent development framework to nurture and develop human capital. The initiatives included: 1) the revamp of the education system to raise student outcomes, 2) raise skills to increase employability, and 3) reform the labour market to ease into a high-income nation (MP10 2011, 194). MP10 mandated the Ministry of Education (MOE) to comprehensively review and assess the education system and propose reforms. At the core of innovation and the productive high-income economy is human capital and MP10 acknowledged that a significant gap existed in its development (MP10 2011, 196).

MP10 introduced the National Key Result Areas (NKRA) to improve student performance (MP10 2011, 197).

1. Exact high expectations for all students regardless of background and provide systematic help and support to students falling behind;
2. Hold schools accountable for changes in student outcomes and provide guided autonomy to schools in exchange for improved student outcomes;
3. Invest in suitable leaders for every school through rigorous selection, training, and robust performance management of headteachers and principals; and
4. Attract and develop top talent in the teaching profession by making the profession attractive, improving the quality of practicum, and implementing rigorous performance management and world-class continuous professional development.
5. Evaluate teachers' performance like other civil service personnel.

As the move to the high-income status intensified, the need to nurture and build a critical mass of technical and vocational qualified workforce became imminent, resulting in the heavy promotion of technical and vocational Education (TEVT) as mainstream education similar to other developed countries (MP10 2011, 216). A binary or 'dual-pathway' was adopted to make this stream accessible to students (MP10 2011, 216).

Four strategies were used to promote technical and vocational studies:

1. Improve the perception of TEVT to attract more trainees.
2. Develop highly effective TEVT instructors
3. Upgrade and harmonise TEVT curriculum; and
4. Streamline the delivery of TEVT (MP10 2011, 216).

The demand for scientists, engineers, patent agents, and technopreneurs was also essential for innovation-focused economies. Hence, the following strategies were adopted to strengthen the higher learning institutions:

a. Strengthen Industry and research collaboration;
b. Provide autonomy to universities and strengthen performance culture;
c. Upgrade curricula to balance academic content and soft skills; and
d. Hire and retain high-quality faculty (MP10 2011, 223)

The Knowledge Transfer Partnership (KTP) program was introduced in 2011 to facilitate the industry and universities research collaboration ventures (MP10 2011, 224). Simultaneously, a standard policy framework for structured industrial attachment programs was implemented for higher learning institutions collaborating with industry to improve such programs' effectiveness. This framework expanded industrial attachment programs for disciplines and courses beyond those mandatory clinical training such as medicine, dentistry, and nursing. Industrial attachment programs for faculty members were intensified to ensure that no less than 15 percent of faculty members gain at least six months of industrial experience every five years (MP10 2011, 224).

Universities were encouraged to develop strategic collaborations with international research institutions and foreign universities to enhance research and development (R&D) activities, especially in new emerging technologies, by:

1. Implementing attachment programs to enable lecturers to share knowledge, explore new ideas to raise their research quality and promote the exchange of faculty members;
2. Strengthening management of intellectual property developed in universities to improve the governance of research activities; and
3. Strengthening centres of excellence in universities through industrial collaboration in R&D activities to support and accelerate the commercialisation of innovations and new technology (MP10 2011, 274-275).

In strengthening performance culture, a rating system for Malaysian Higher Education Institutions (SETARA) was introduced for public universities and extended to all private tertiary institutions. This new standardised performance rating produced a uniform and objective assessment of performance to raise the overall quality of education. Funding for the university was linked to the SETARA rating (MP10 2011, 226).

During MP10, higher education institutions undertook an exercise to review their curricula and courses and align program and learning outcomes with industry and employers' requirements. A total of 2,730 existing programs were reviewed for compliance with the Malaysian Qualification Framework on the following basis (MP10 2011, 227):

1. Content benchmarked against nationally agreed criteria and standards in line with international best practices; and
2. Development of soft skills, such as positive work ethics, communications, teamwork, decision-making, and leadership skills.

Following MP9, efforts to increase the number of faculty with PhD qualifications continued. In 2009, 35.9 percent had PhD, and the target was to increase this to 75 percent for research universities and 60 percent for other public universities by 2015. Consequently, the MyBrain15 program object was 18,000 PhDs by 2016 and 60,000 by 2023 (MP10 2011, 228).

MP10 identified that only 28 percent of the total workforce was employed in higher-skilled jobs, reflecting the low educational attainment. This situation needed change, and the Malaysian Government targeted 33 percent of the workforce to move up the value chain by 2016 and 60 percent by 2020 (MP10 2011, 212).

The tables below summarise the initiatives promoted under MP10 to raise the capability for knowledge and innovation and build a *First Class Mentality* (MP10 2011, 393)

Commitment	Output
Improving Education Quality and Accessibility	
Equal opportunityto quality education	• The number of primary schools increased from 7,601 in 2005 to 7,664 in 2009 • The number of secondary schools increased from 2,028 in 2005 to 2,219 in 2009 • Clean water supplied to 555 schools in rural areas benefiting more than 200,000 pupils (as of March 2010) • All rural schools in Sarawak and 92% in Sabah provided with adequate electricity supply (as of March 2010) • Projects for solar energy were initiated to complement the existing electricity supply to 102 remote schools in Sabah (as of March 2010)
All pupils able to read and write before formal education	• Pre-school participation rate for children aged 4+ to 5+ year-olds rose from 63% in 2005 to 67.6% in 2009
Making National Schools the School of Preferred Choice	
• **Quality teachers that will increase the appeal of national schools** • **Improve teaching and learning methods to enhance the quality of national schools**	• Graduate teachers for primary and secondary schools are 28.0% and 89.4% (2010) • Established internet access centres in 30.6% or 3,025 schools (2010)

Note: Output as of December 31st, 2009

Source: MP10 (2011, 393)

Commitment	Output
Creating Tertiary Institutions of International Standing	
• Malaysia as aregional educational hub	• Increased proportion of academic staff with PhD qualification in public universities from 26.6% in 2005 to 35.9% in 2009 • 4,156 lecturers in public universities pursued PhD qualification • Enrolment of postgraduate was 19.5% in public institutions • Accelerated Program for Excellence (APEX) was introduced to raise the performance and competitiveness of the public universities • Rating System for Malaysian Higher Education (SETARA), was introduced in 2007 to enhance the quality and promote

Nurturing Quality R&D and Enhancing Scientific and Innovation Capabilities	
• Increase capability for scientific R&D and innovation to move the economy up the value chain	• The ratio of research scientists and engineers per 10,000 labour force was 20.3 (2008)
Fostering a Society with Strong Values	
• United society with high patriotism and integrity	• 430,776 youth benefited from National Service Program (2010) • 1,896,496 participants benefited from National Civics Bureau programs

Table 47 Initiatives to Develop Knowledge for Innovation

Source: MP10 (2011, 395)

At MP10 initiation, 175,000 applications were pending entry into the teaching profession, but only 20,000 were placed into schools annually (MP10 2011, 206). Top performing students somehow avoided the teaching profession. By contrast, in Finland and South Korea, only graduates in the top 15 percent and 10 percent respectively were eligible to apply for teacher training programs (MP10 2011, 207). Hence, the profession is highly ranked.

Due to massive investments in building post-secondary and higher education, access increased. The following were the numbers of institutions according to the level of Education (MP10 2011, 215):

Type of Institute	**No**
Public Universities	20
Private Universities	26
Public Skills Training	406
Private Skills Training Institute	584

Table 48 Number of Institutions Post-Secondary Education

Source: MP10 (2011)

This increased facility culminated in 181,000 graduates, including more than 81,000 graduates from private higher education institutions. Malaysia's workforce with tertiary education stood at 23 percent, whereas the average OECD countries stand at nearly 28 percent, with countries like Singapore and Finland recording as high as 36 percent. MP10 identified that most graduates remained unemployed and, if employed, failed to earn more than RM1,500 per month (MP10 2011, 215).

Five years on, human capital development was still highlighted in MP11 as pivotal for Malaysia's economic growth plans. The focus was improved 1) labour market, 2) TVET transformation, 3) lifelong learning, and 4) education quality. Besides improving the quality of education through knowledge and skills, ethics and morality were pursued to produce a workforce that thrives in a globally competitive and dynamic environment (MP11, 1-9). Hence, as part of its human capital development agenda, the National Human Capital Development Council promoted quality education through knowledge and skills and ethics and morality development to create a globally competitive and dynamic workforce (MP11 2016, 5-15).

MP11 targeted 60 percent of jobs to be created related to TVET skills, making it the most important avenue for increasing skilled human capital base (MP11 2016, 5-19). The following strategies were pursued:

Strengthen TVET governance	1. Streamline and consolidate TVET to allow better coordination and monitoring. **2.** Harmonies the various rating systems into a single system (MP11 2016, 5-19)

Improve the quality and delivery of TVET programs	1. Encourage industry-led programs to reduce skills mismatch (MP11 2016, 5-19) 2. Make the National Dual Training System (NDTS) mainstream. 3. Eliminate low-impact and overlapping programs (MP11 2016, 5-20)
Rebrand TVET	1. Promote TVET as a pathway 2. Recognise technologists as professionals (MP11 2016, 5-22)

Table 49 Initiatives for TVET, 2016-2020
Source: MP11 (2016)

During MP10, the labour market reform induced changes to the education system, resulting in an increased technically qualified workforce from 113,000 in 2010 to 164,000 in 2013 (MP11 2016, 5-1). The Malaysia Education Blueprint (2013-2025) for pre-school to post-secondary schooling and the Malaysia Education Blueprint (2015-2025) for higher education, supported by the Talent Roadmap 2020, were preparing the workforce upskilling path (MP11 2016, 5-1).

Whereas, TVET delivery converted 72 existing vocational schools and eight technical schools into Vocational Colleges besides establishing eight more (MP11 2016, 5-7). At the same time, enrolment in public and private universities increased with increased PhD enrolments. Universities showed signs of performing at the research front by filing a total of 4,030 patents, with 314 granted between 2010 and 2013 (MP11 2016, 5-10). Interestingly, academic staff with PhD qualifications increased by 36.5 percent in 2010. Though so, no breakdown of the areas of PhD qualifications was made available. In 2013, academic staff with PhD qualifications increased, which indicated a more research-active faculty.

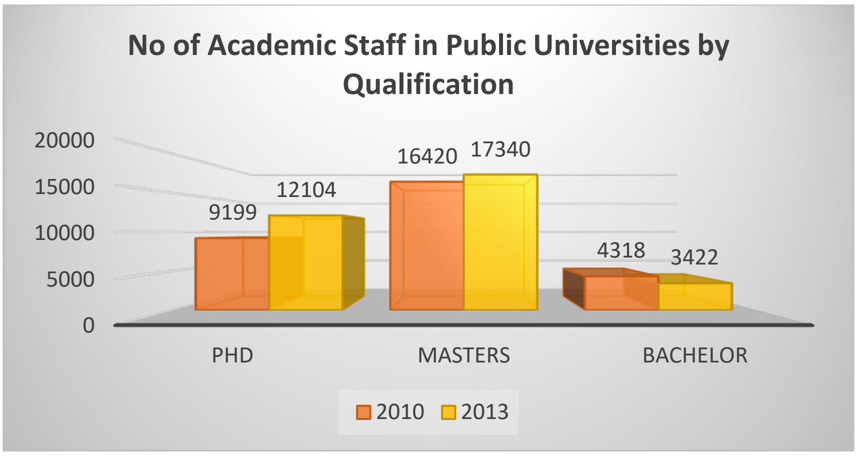


Figure 22 Qualification of Academics in Higher Education, MP11
Source: MP11 (2016, 5-12)

Following the qualification of staff with PhD, the net result was seen with the tremendous increase in publication and citations of research work.

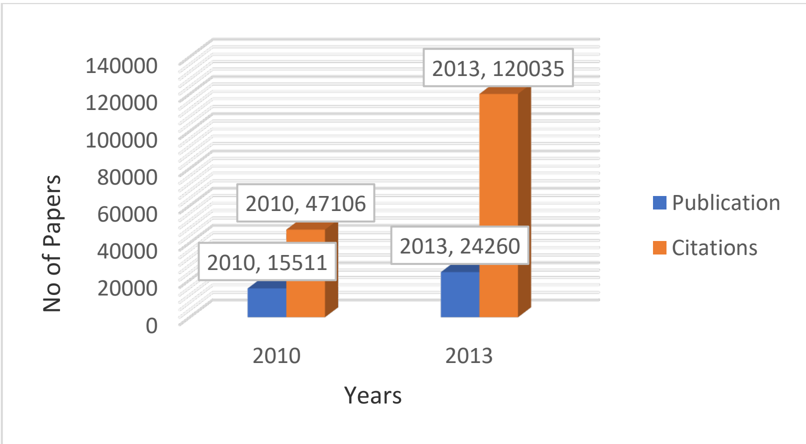


Figure 23 Publications and Citations, 2010 and 2013
Source: MP11 (2016)

7.5 R&D

MP5 was the turning point in developing Science and Technology (S&T) in a consolidated manner to formulate and execute S&T policy initiatives (MP6 1991, 187). MP6 aimed to continuously develop S&T to retain high economic growth, accelerate development, and attain a scientifically and technologically advanced society by 2020 (MP6 1991, 187).

However, it contended with a low level of R&D expenditure and technological innovation amongst domestic firms (MP6 1991, 192), and a heavy reliance on foreign technology sources and in-house R&D was insignificant (MP6 1991, 192). Pointedly, imported technologies were essential to building innovation capability and reflected by the inflow of technology proxied by the government's contractual agreements, as shown in **Table 50**. However, the data is restrictive, highlighting only those bound by the requirements of disclosure under specific legislation, e.g. Industrial Coordination Act (ICA) 1975 (MP6 1991, 192)

Type of Agreement	1985	1986	1987	1988	1989	1990	MP[58]5
Joint venture	9	19	11	11	15	16	72
Technical Assistance	46	47	50	64	64	75	298
Know-how	5	3	3	3	13	11	33
Licenses and Patents	14	27	22	37	35	13	136
Management	6	10	5	7	12	5	39
Services	1	1	1	2	12	5	21
Trademark	5	6	8	7	18	19	58
Turnkey and Engineering	0	1	0	1	1	1	4
Supply and Purchase	1	0	1	0	6	2	9
Sales, marketing/distribution	7	7	7	10	6	5	35
Others	2	2	2	8	16	4	32
Total	96	123	110	150	198	156	737

Table 50 Technology Imports by type of Agreement, 1985-1990
Source MP6 (1991, 193)

Despite increasing public education and training institutions' capacity, the increasing demand for specialised skills, mainly engineers, technicians, and R&D personnel, was not

[58] Excludes the numbers in 1985

ebbing (MP6 1991, 195). **Figure 24** provides a snapshot of the condition of the R&D workforce and qualification at the tail-end of MP5.

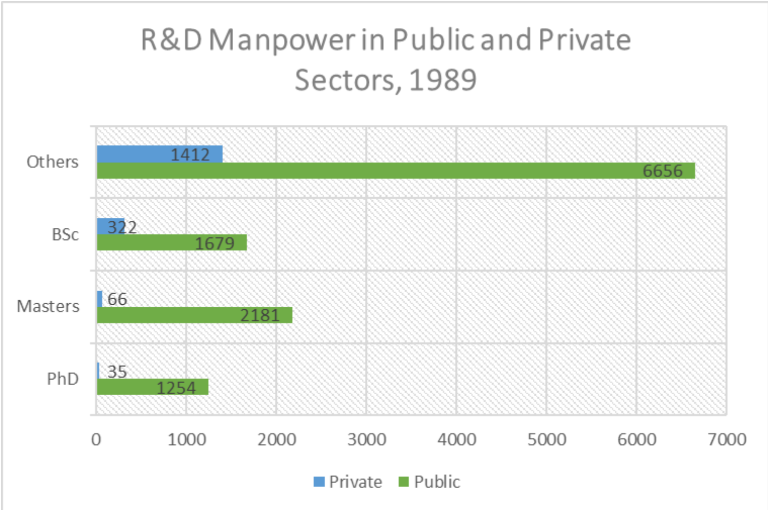


Figure 24 R&D Manpower in Public and Private Sectors, 1989
Source: MP6 (1991, 195)

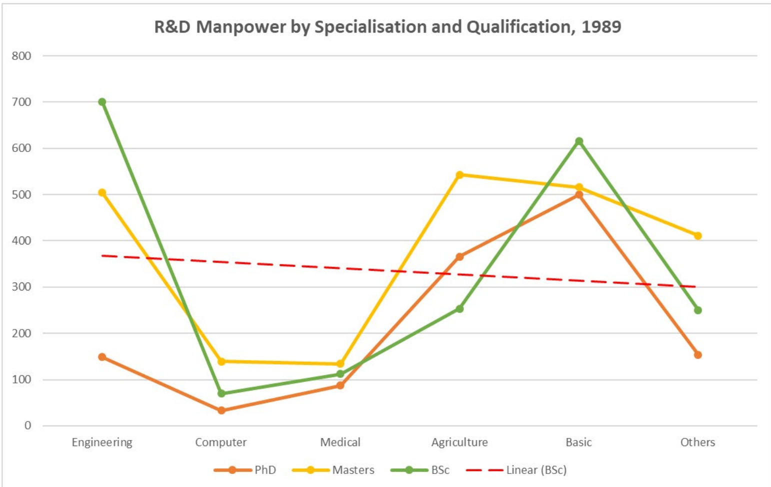


Figure 25 R&D workforce by specialisation and qualification, 1989
Source: MP6 (1991, 196)

MP6 explicitly intended to strengthen the S&T base and R & D capabilities – a notable milestone in its economic planning strategy. R&D competence in industrial sectors – particularly interaction between research institutions and private sectors; encouraging relevant research and commercialisation – to achieve productivity and competitiveness (MP6 1991, 53). Priority under R&D was to enhance technology adaptation, innovation, and utilisation according to industrial and export requirements (MP6 1991, 78). Emphasis was on raising technology content, efficiency, and productivity (MP6 1991, 78).

MP6 following MP5 continued improvement on the policy framework, infrastructure, incentives, and support services, including promoting indigenous technology development, technology absorption, adaptation, innovation, and exploitation, aligned with industrial and export needs (MP6 1991, 197). MP6 wanted to build endogenous capability in S&T by introducing basic sciences and technology-oriented instruction at primary, secondary, and tertiary levels of education (MP6 1991, 198). S&T policy intended to integrate private-sector research activities into the national R&D framework.

MP6 highlighted the following programs:

Program	Measures
Diffusion and Applications of Advanced Technology	1. Access to advanced technology through FDI, technology licensing, and trade activities 2. The Industrial Technical Assistance Fund (ITAF) was introduced to match grants in support of product development and design for SMIs. 3. Provision of techno-infrastructure and facilities and technical services. 4. Financial assistance to encourage private firms to commercialise and market technology. The joint venture between private organisations with public research institutions and universities to be encouraged – through the secondment of scientists and researchers.

Increasing Quality and Design Competence	1. SIRIM upgraded to form the National Product Design Centre to provide consultancy services to industries in product design, prototyping, and product development – particularly for SMIs.
Education and Training in S&T	1. Expand domestic education and training programs in science, engineering, and technology by upgrading S&T curricula and skills development. 2. Human Resource Development Fund was launched to develop indigenous technological capability.
Support for the Science Base	1. Key disciplines for emphasis will be 1) molecular biology and genetics, 2) chemistry, 3) physics, 4) mathematics.
Enabling and key technologies	1. Five key technology areas identified for competency building: a. Automated manufacturing technology b. Advanced Materials c. Biotechnology d. Electronics e. Information Technology
The commercialisation of Research and Technology	1. Several options were explored, including establishing an intermediary agency to facilitate the exploitation and technology parks and innovation centres.
Intellectual Property Policy for Commercialisation	1. Policies and guidelines to provide flexibility to develop license agreements, sponsored research contracts, etc
Role of Universities	1. Increase in Postgraduate education and training

Table 51 Key programs in MP6

Source: MP6 (1991, 200-208)

The priority of promoting science, research, and technological innovation as part of its development strategy – to maintain high growth rates and improved living standards continued in MP7 (MP7 1996, 419). The strategy implemented pushed for productivity-driven growth and competitiveness and relied on increased use of technology, knowledge, and skills to enhance industrial competence and productivity (MP7 1996, 433). Emphasis was on increasing indigenous innovation capability and accelerating the environment for technology development (MP7 1996, 433).

The table below summarises the initiatives planned under MP7

Initiatives	Description
Policy and institutional reform	to strengthen the S&T planning and management system
Optimise use of skills and capital	1. Promotion of adaptation and application of new and improved technologies 2. Undertaking commercially oriented R&D 3. Increase the capability to innovate, design, and market domestic technologies
Increase R&D investment, and S&T education and training	develop a critical mass of scientists, engineers, and researchers to foster creativity and innovativeness
Develop the domestic technological capability	in new enabling technologies to yield higher economic returns
R&D and technology development cooperation	between industry, universities, and research institutes
Promote Private Sector Participation	In the acquisition, development, and transfer of new and specialised technologies
MNC friendly environment	To encourage investment in new high technology industries with high local content and linkages.
special programs	to augment technological capabilities among SMIs
Strategic linkages and joint ventures	international cooperation in S&T
Nurturing domestic innovations and inventions	changing international environment for technology transfer

Table 52 Summary of MP7 R&D initiatives

Source: MP7 (1996, 433-4)

MP7 focused on improving TFP – optimising labour and capital through improving the quality of the capital, workforce, and work systems (MP7 1996, 434). Hence, education and training, technical progress, entrepreneurship development, application of new and improved technologies, commercial R&D, and increased ability to innovate were important (MP7 1996, 434). A long-range scientific and technological human resource development policy was initiated to enhance technology capability believed to supply the critical mass of higher-level S&T workforce required by industry(MP7 1996, 435). This strategy intended to exploit the competence-building potential of international technology transfer through importing technology (MP7 1996, 435).

In priority areas, R & D was promoted in sectors that Malaysia could reap the most benefit from (MP7 1996, 436). A national approach to accelerate strategic technology development was adopted cognisant of high risks and costs associated with investments in these sectors (MP7 1996, 436). The strategic technologies and emerging industries promoted were as follows:

Information technology and communication	**Microelectronics**	**Biotechnology and life sciences**	**Advanced manufacturing technology**	**Advanced materials**	**Environment and energy-related**
High-performance computing	Sensor technology	Biotechnology materials and processes	Flexible computer integrated manufacturing	Composites	Green Materials
Networking	Semiconductor materials and microelectronics circuits	Medical devices and diagnostics	Machine intelligence and robotics	Ceramics	Argo-based waste
Communications	Optoelectronics	Medical technology	Micro and nano-fabrication	Semiconductor materials, microelectronics circuits and photonic materials	Renewable energy
Digital imaging	Avionics		Systems management technology	Superconductors	Portable energy

Multimedia	Advanced semiconductor devices	[redacted]	[redacted]	High-performance metals and alloy	Pollution minimisation, remediation, and waste management
High-definition display	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
High-density storage	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Software	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Simulation and modelling	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Table 53 Summary of Technologies and Emerging Industries
Source: MP7 (1996, 437)

During MP7, a National Survey of Research and Development was conducted, which revealed that the private sector spent RM746.1 million in 1998 compared to RM400.1 in 1996, and of this total, most were for the introduction of new equipment, systems, or processes (MP8 2001, 247). Most foreign R&D expenditure was on the electronic equipment industry, and local R&D was on a varied cross-section of industries (MP8 2001, 247). Additionally, only one-third of the companies carrying out R&D activities were SMEs (MP8 2001, 247). The Plan highlighted that the main setback for the improvement in R&D was the lack of skilled personnel (MP8 2001, 247).

MP7 reviewed the S&T policy and prepared a framework and operational strategies to meet the innovation and technology agenda (MP8 2001, 140). The review laid out action plans to accelerate capacity and capability development in S&T knowledge and skills. During MP7, R&D expenditure increased to RM1.1 billion and contributed 0.4 percent to the GDP (MP8 2001, 341). R&D activities in the same period by the private sector increased from

196 to 273 (MP8 2001, 341). R&D activities were mainly on applied research and development and basic research. Whereas public sector R&D expenditure was RM935 million, and these were primarily in the area earmarked as priority areas by Malaysian policymakers (MP8 2001, 342). The identified research priority areas were 11 and aligned with the requirements highlighted by IMP2 (MP8 2001, 342). The following is the project approvals under the Intensification of Research in Priority Areas (IRPA) by area of research.

Area	Projects Approved		Value	
	Number	%	RM Million	%
Agro-industry	1255	33.9	178.67	25.6
Construction	95	2.5	23.76	3.4
Energy	134	3.6	37.27	5.3
Environment	164	4.4	46.97	6.7
ICT	110	3.0	34.95	5.0
Manufacturing	321	8.7	71.77	10.3
Medical	548	14.8	96.99	13.9
Material and Geoscience	37	1.0	14.97	2.1
Science Engineering	725	19.5	114.5	16.4
Services	66	1.8	14.97	2.1
Socio-economic	212	5.7	16.08	2.3
Biotechnology	32	0.9	28.84	4.1
Photonics	6	0.2	18.54	2.7
Total	3705	100	698.28	100

Table 54 IPRA Program approvals by area of research

Source: MP8 (2001, 343)

R&D funding increased to RM1 billion and RM2 billion and was channelled to infrastructure facilities and services (MP7 1996, 446). The following were the allocation for S&T initiatives as planned by MP7.

(RM million)			
	MP6		**MP7**
Program	**Allocation**	**Expenditure**	**Allocation**
Direct R&D	629.0	567.1	1,000.0
Technology Development for SMIs	-	-	100.0
Technology Acquisition	-	-	100.0
Commercialisation of Technology	-	-	100.0
S&T Infrastructure and Development	807.7	629.2	1749.0
Total	1,436.7	1,196.3	3,049.0

Table 55 Development Allocation for Science and Technology, 1991-2000

Source: MP7 (1996, 446)

The Malaysian policymakers prioritised innovation-driven and technology-led development. Hence improved skills and management abilities in R&D were pivotal. MP8 rolled the strategies under this period, taking heed of this overarching goal (MP8 2001, 352).The following is a summary of the key strategies initiated during MP8:

Initiative	**Description**
Integrated approach in the use of R&D resources	a. Public sector funding to concentrate on the commercialisation of R&D findings b. IPRA funding mechanism to be realigned to development of innovations and commercial relevance R&D activities c. Priority for research in manufacturing, plant production and primary products, ICT, health, and education and training. d. Also, in emerging technologies, e.g., optical technology, fine chemicals technology, design and software technology, nanotechnology, and precision engineering (MP8 2001, 352-354)
Accelerate the commercialisation of R&D findings	a. Incentive scheme for commercialisation of R&D reviewed to encourage commercialisation and undertaking of market-oriented R&D (MP8 2001, 354)

Increase Private Sector participation in R&D	a. Fiscal incentives were reviewed to promote greater private sector participation in R&D.
Increase the supply of S&T workforce	a. Investment in scientific and technological education increased b. Enrolment in science to be increased to a 60:40 ratio c. Malaysian scientists and engineers residing overseas to be enticed back through the introduction of incentive package including tax exemption on income remitted and for personal effects brought back d. To encourage research culture in institutions of higher learning (MP8 2001, 355)
Acquire new and imported technologies	a. Technology transfer program involving the placement of Malaysian technical personnel in technology-based companies will be undertaken. b. Relocation of foreign-based manufacturing and R&D facilities in Malaysia
Develop indigenous S&T capability in crucial technologies	a. National Technology Mapping Program will be undertaken to increase the domestic capability b. Biotechnology R&D will be intensified c. ICT and multimedia will be developed d. Increasing capability in low-power microelectronics, e. National Space Agency will be established to integrate and coordinate the development of space and satellite technology (MP8 2001, 368)
Strengthen the technological capability of SME	SIRIM Berhad, MIMOS Berhad, and Technology Park Malaysia and universities will accelerate technical assistance to SMEs (MP8 2001, 359)

Table 56 Table of S&T Initiatives, MP8

Source: MP8 (2001)

MP8 allocation for R&D from 2001 to 2005 were as follows:

Program	MP7		MP8
	Allocation (RM Million)	Expenditure (RM Million)	Allocation (RM Million)
IRPA	755.0	718.1	1000.0
Malaysia-MIT Biotechnology Partnership	35.0	33.3	-
Technology Development for SME	58.0	41.2	30.0
Technology Acquisition Fund	118.0	118.0	250.0
Commercialisation of Technology	208.0	203.9	620.0
S&T Infrastructure and Development	2413.3	1496.7	2818.9
Total	3587.3	2611.2	4708.9

Table 57 Development Allocation for Science and Technology, 1996 – 2005

Source: (MP8 2001, 359)

MP9 positioned science, technology, and innovation (STI) as the primary driver for elevating national capacity to acquire and use knowledge and foster innovation (MP9 2006, 263). MP9 intended to strengthen the National Innovation System (NIS) to increase productivity and competitiveness (MP9 2006, 263). Priority was accorded to market-oriented R&D and consequently increasing commercialisation. The target was to increase the national R&D expenditure to 1.5 percent of GDP by 2010, with the private sector contributing more than 70 percent (MP9 2006, 269). As for the Researchers, Scientists, and Engineers (RSEs) per 10,000 workforces, the target was 50 (MP9 2006, 269). The following is the summary of the initiatives pursued under MP9:

Initiative	Details
Strengthen NIS	A. The National Innovation Council is to be established to provide leadership in formulating policies and essential strategies to stimulate innovation at national and firm levels. B. IP frameworks will be strengthened (MP9 2006, 271)

Enhance S&T human capital	a. To generate demand for RSEs, centres of excellence in emerging technology will be set-up. b. R&D capacity of universities and research institutions to be upgraded c. S&T human resource development will be improved to develop key competencies in strategic research areas d. Postgraduate programs to be given emphasis
Promote Technopreneurship	a. Technology incubator program to be enhanced to develop a sustainable pool of indigenous technopreneurs b. Bumiputera S&T will be nurtured.
Improve technological capability and capacity of SMEs	a. Programs to nurture local SMEs as R&D partners to tap opportunities of R&D by MNCs and Government Linked Companies (GLCs)
Prioritise and consolidate R&D and commercialisation	a. R&D and commercialisation funding mechanism to be realigned b. To commercialise at 10 percent of the public-funded R&D projects
Targeted R&D	a. To build competence in the following technologies: 1. Biotechnology 2. ICT 3. Semiconductors and microelectronics 4. IPv6, Grid Computing and Language Engineering 5. Information Security 6. Advanced materials and manufacturing 7. Nanotechnology
Promote standardisation and quality assurances	a. implementation of the National Standards Strategy and Action Plan to expedite the development of Malaysian standards
Increase STI awareness	a. Awareness to create a culture of creativity and innovation

Improve international linkages in STI development	a. Bilateral cooperation agreements will be translated into outputs in STI development in Malaysia.

Table 58 Summary of initiatives for STI under MP9

Source: MP9 (2006, 270-9)

During MP9, the allocation for the development of science, technology and innovation was as follows:

Program	MP8 Expenditure	MP9 Allocation
R&D	926.6	1,581.6
Technology Acquisition Fund	70.7	142.5
Commercialisation of Technology	267.5	1843.3
S&T HR development and awareness	123.1	650.6
S&T infrastructure	1950.0	1035.1

Table 59 STI Allocation, 2001-2010

Source: (MP9 2006, 279)

IRPA funds, which were direct public sector R&D investment, were channelled to areas of advanced manufacturing, advanced materials, biotechnology, environmental technology, electronics, ICT, and photonics. Private sector R&D was developed through IGS, MSC, MGS, and DAGS (MP9 2006, 265). The commercialisation of R&D projects funded under the IPRA program seems to be lagging. Of those approved during MP7, only 3.4 percent were commercialised during MP8 (MP9 2006, 266).

Using the Second Science and Technology Policy and the IMP2 as the blueprint, the effort to strengthen indigenous capacity and capability in key technology areas focused on biotechnology, ICT, advanced manufacturing, advanced materials, aerospace-related technology, and nanotechnology (MP9 2006, 267).

Emphasis was placed on patents, given that it was a proxy of innovation. As a result, the number of patents granted to residents increased from 24 in 2000 to 37 in 2005 (MP9 2006, 268). To this end, the Intellectual Property Corporation of Malaysia (MyIPO) was created (MP9 2006, 268).

Simultaneously, the number of S&T graduates increased at an average annual rate of 25.3 percent (MP9 2006, 269).

MP10 promoted innovation-driven entrepreneurship to enable Bumiputera Malays entrepreneurs to move to higher-value-added segments (MP10 2011, 169). Further, 1-InnoCERT was introduced to certify SMEs based on innovation and commercialisation achievements. These SMEs received a tax deduction for their R&D activities. This certification program aimed at certifying 600 SMEs by 2015 (MP10 2011, 98).

The IP regime, including personnel and institutional capacity, were improved and upgraded to provide a dynamic environment for creating new and innovative products and services. The approval system needed to be expedited (MP10 2011, 86).

Funding needs for early development and commercialisation stages were supported by the Government (MP10 2011, 86). Through MDTC and Malaysian Venture Capital Management Berhad, the lending model shifted from the current lending mode to equity-based (MP10 2011, 86). A *Mudharabah* Innovation Fund was introduced with an RM500 million allocation (MP10 2011, 86).

The progress and achievements of MP10 for R&D were as follows:

Commitment	Output
Enhancing Productivity and Competitiveness	
• Increase value-added and share to GDP of the services sector	• Increased value-added of the services sector by 6.9% to RM1,112.2 billion • Increased share of the services sector to GDP to 57.9%
• Increase the contribution of tourism to foreign exchange earnings	• 23.6 million tourist arrivals with receipts of RM53.4 billion • Increased tourist per capita expenditure to RM2,103.5
• Increase investment and value-added in the manufacturing sector	• Value-added of the manufacturing sector increased by 0.2% to RM590.4 billion • Value-added of major subsectors in 2009: E&E RM40.1 billion M&E RM3.7 billion Petrochemical RM28.8 billion Transport equipment RM15.3 billion • Average annual investment level of RM38.5 billion • Investment by significant subsectors: E&E RM8.0 billion M&E RM2.0 billion
• Increase gross expenditure in R&D	• Gross expenditure on R&D to GDP at 0.21%[1] Note: 1 Preliminary data for the year 2008

Note: Output as December 31st, 2009

Table 60 Achievements of R&D, 2006-2010

Source: MP10 (2011, 386)

To sustain economic growth and improve the wellbeing of the Malaysian population, the focus of MP11 was on strengthening relational capital to build strong linkages, collaboration, and trust with stakeholders (MP11 2016, 8-31). Hence, efforts were to promote innovation at both enterprise and societal levels. Efforts to enhance innovation at the enterprise level relied on four strategies which are as follows (MP11 2016, 8-31):

1. Strengthening the governance mechanism by creating a research management agency (RMA) and expanding the iDana Portal.
2. Increasing demand-driven research by streamlining public sector funding for research, development, commercialisation, and innovation
3. Strengthening industry-academia collaboration through intermediaries by encouraging local and international partnerships for technology transfer, including strategic alliances between MNCs and SMEs; and
4. Promoting private financing of research development, commercialisation, and innovation by increasing access to private financing sources and developing a framework for risk mitigation and management of crowdfunding activities.

The data below provides a snapshot of the expenditure undertaken in 2010 and 2012 for R&D purposes. The investment does not seem to commensurate with the output, as indicated in this table.

	2010			**2012**		
	RM Billion		**%**	**RM Billion**		**%**
R&D Expenditure by Sector						
Total GRIs and IHLs	2.98		35	3.77		35.6
Government Research Institutes (GRIs)	0.52		6	0.73		6.9
Institutions of Higher Learning (IHLs)	2.46		29	3.04		28.7

Business Enterprises (Bes)	5.53		65	6.84		64.4
Total	8.51		100	10.61		100
GERD/GDP (%)		**1.07**			**1.13**	
Human Resources in R&D						
Total Headcount of R&D personnel		88314			103986	
Total Full-Time Equivalent (FTE) of R&D personnel		50484			62807	
Researchers per 10,000 labour force		53.08			57.45	
Type of Research (expenditure)	**RM Billion**		**%**	**RM Billion**		**%**
Basic Research	1.52		17.9	3.66		34.5
Applied Research	5.8		68.2	5.36		50.5
Experimental Research	1.19		13.9	1.59		15
Total	8.51		100	10.61		100

Table 61 R&D Expenditure 2010 and 2012

Source: MP11 (2016)

7.6 Conclusion

This Chapter traced the critical drivers of innovation capability development from 1991 to 2016, providing an insight into how the institutions and factors of economic policies, education and skills and innovation (R&D) have developed in Malaysia. There have been various structural changes that the Malaysian policymakers have planned. Essentially, at each period, the will of the leader prevailed. As can be seen from the narrative, the strong push by the then prime minister Tun Dr Mahathir Mohamad had been the primary reason for the venture into heavy industries and the car project. These structural changes seemed very sudden as the plans did not give any indication of such intended transition, which given Malaysia's economic development stage, was a radical shift.

The historical narrative pointedly suggests that whilst the policymakers were aware of the shortage of qualified and skilled workforce, they still proceeded with those structural changes. Although it is not an impeding factor to make structural changes at opportune times, it needs to be further understood whether the innovation system was being prepared equally to meet those changes. The tie-in with NEP or metamorphosed NDP considerations have become a lock-in for the policymakers. Their intention of social re-structuring has far exceeded its needs and began to have an impact on economic policies. Additionally, while institutions were established, their interactions and how they were monitored and evaluated were not clear from the Malaysian Plans. Chapter 8 will elucidate these interactions and the policymakers' success (or otherwise) in bridging the need for an innovative workforce. The discussion will investigate particularly the earmarked industries by the policymakers, which will explain the situation that Malaysia is in and how this can be overcome.

Chapter 8: Evaluation of Malaysia's National Innovation System

8.1 Introduction

In Chapter 5, the methodology and the framework utilised to analyse the data were elaborated. The economic goals and institutions established to build the National Innovation System and innovation capability were identified in Chapters 6 and 7. The analysis in this Chapter will answer the research questions of whether the institutions interacted to achieve the targets and whether they were monitored and corrected. Based on these analyses, a correlation may or may not be established between the policies and innovation output.

In the forthcoming section, factors related to interactions of the institutions in developing education, skills and R&D are analysed. Since the policymakers hand-picked automotive and through FDI had electrical and electronics as the forerunning economic contributors, the analysis in this part will primarily concentrate on these two industries to establish the preparedness of the innovation system via innovation capability from the inception and growth of the said industries. This selection is amplified because the manufacturing sector was the primary sector that the policymakers had concentrated on, as evidenced from **Table 62.** As indicated, agriculture and mining were the strong forts for Malaysia at the initial stages, which eventually tapered off. Mining shifted concentration to gas and oil with the finding of petroleum, and agriculture was no longer the primary focus of the policymakers. However, as can be seen, manufacturing has been the mainstay of the economic activities in Malaysia and became more diversified overtime when the focus shifted to other sub-sectors. Nevertheless, the Electrical and Electronics, and Automotive sub-sectors were the pillars of the manufacturing sub-sector. While the policies, strategies, and institutions set could be unravelled from the Malaysia Plans, operationalising those strategies was unavailable. This factor was significantly missing from all the plans.

INDUSTRY SECTORS HIGHLIGHTED BY MALAYSIA PLANS, 1965-2016

MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	MP9	M910	MP11
Agriculture	**Agriculture**	**Agriculture**	**Agriculture**	**Agriculture**	**Agriculture**	**Agriculture**	**Agriculture**	**Agriculture**	National Key Economic Areas	Chemicals
Rubber	Rubber (declining)	Rubber (decline)	Palm Oil	Palm Oil	Palm Oil	Palm Oil	Palm Oil	Palm Oil	Oil & Gas	**Electrical & Electronics**
Palm Oil	Palm Oil (increasing)	Palm Oil (expand)	Rubber	Rubber	Rubber (decline)	Rubber	Rubber	Rubber	**Palm Oil & Related Products**	Machinery & Equipment
									Financial Services	Medical Devices
Mining	**Mining**	**Mining**	**Mining**	**Mining**	**Mining**	**Manufacturing**	**Manufacturing**	**Manufacturing**	Wholesale Retail	**Rubber based**
Tin	Tin	Petroleum and Gas	Petroleum and Gas	Petroleum	Oil & Gas	**Electrical & Electronics**	**Electrical & Electronics**	**Electrical & Electronics**	Tourism	Wood based
	Petroleum (entry)	Tin (decline)	Tin (decline)	Tin (decline)		Textiles	**Automotive Industry**	**Automotive**	Information & Communications Technology	Textile
						Chemicals & Chemical Products	Aerospace Industry	Biotechnology	Education	**Palm Oil based**
Manufacturing	**Manufacturing**	**Manufacturing**	**Manufacturing**	**Manufacturing**	**Manufacturing**	Aerospace (new)	Wood Based Products	Advance Manufacturing	**Electrical & Electronics**	Pharmaceuticals
Low-End	Import-Substitution Low-End	**Electrical & Electronics**	Textiles	**Automobile**	**Electrical & Electronics**	Materials & Advance Materials	Chemical and Chemical Products	Petrochemicals	Business Services	Transport
Textiles	Textiles	Textiles	**Electrical & Electronics**	Iron & Steel	Textiles & Apparels	Petrochemicals (new)	Pharmaceutical	Machinery & Equipment	Private Healthcare	Metal
			Iron & Steel	**Electrical & Electronics**	**Automotive Assembly**	Telecommunications		Aerospace	Agriculture	Aerospace
			Heavy Industry	Chemical & Chemical Processing	Machinery & Engineering	**Automotive**		Handicraft Industry	Greater Kuala Lumpur	Food Processing
			Machinery & Equipment	Textiles & Apparels		Machinery and Engineering (support automotive)				Re-Manufacturing
			Petro-chemicals			Iron & Steel				
Labour-Intensive Industry	Labour-Intensive Industry	No mention of Heavy Industry or Automobile manufacture	No mention of Automobile		Transition to high-tech industries. Concentration on labour intensive industry; yet manpower shortage exists. Portfolio mix still on low-end manufacturing	Move to high-technology		Move to high-technology	Move to high-technology and knowledge industry	Move to high-technology and knowledge industry

Table 62 Industry Sectors

Source: Collated by the Researcher from the Malaysia Plans

8.2 Synopsis of the Automotive and Electrical and Electronics Industries

In the last 30 years of economic planning and development, the Malaysian policymakers actively promoted the manufacturing sector to diversify the economic structure. Inspired by its East Asian counterparts and their successes, the leap of faith was made into heavy industries emulating Japan and Korea. The heavy-industry sectors of choice were car manufacture and steel. These ended up as a significant financial catastrophe for the Malaysian economy. However, discussions will be limited to car manufacturing for this thesis. We will then turn to the electrical and electronics sub-sector, which has been a mainstay of Malaysian economic policy focus.

8.2.1 Car Manufacturing

Proton Saga, the Malaysian pride, became a *saga* of its own to be reckoned with. When the car project was initiated in 1982 (Natsuda and Thoburn 2014, 424, Leutert and Sudhoff 1999, 247), looking at the innovation system concerning innovation capability and the state of the innovation system generally, it was clear that these factors were not in place to the extent that facilitated this industrialisation strategy. As shown in Chapters 6 and 7, Malaysia's educational situation was just taking a turn regarding the number of students enrolled in science-based qualifications. Further, the workforce in technical areas was still lacking. Hence, at that point, the innovation system was immature and unable to cope with the intended shift.

Undoubtedly, setting up a motor industry is a significant leap in industrialisation; therefore, it should have been planned and executed with care. This is said because there is a push away from labour-intensive manufacture into advanced technology and engineering skills – which cannot solely rely on foreign expertise (Segawa, Natsuda, and Thoburn 2014, 422). Although the forward and backward linkages that may emerge from this industry will flourish the economy, it was arguable at the time when the car project was conceived and executed; Malaysia did not have a competitive or comparative advantage to set up car manufacturing nor supporting industries, given the infancy of its innovation system.

Scholars argued that the Malaysian automotive industry, which benefitted from the direct and indirect state intervention, was facing severe challenges in response to the liberalisation pressures from the World Trade Organisation (WTO) and ASEAN Free Trade Area (AFTA), which encouraged competition (Otsuka and Natsuda 2016, 2, Fleming and Søborg 2016, 84, Segawa, Natsuda, and Thoburn 2014, 425). Further, the labour productivity in the manufacturing sectors of electronics, textile, and automotive has been negative since 2000. Due to poor human capital and R&D, it could not move to the higher added value activities (Otsuka and Natsuda 2016, 2). However, the Malaysian policymakers' protective attitude towards the car project only exacerbated the issue, resulting in a dramatic drop in Proton's domestic market (Fleming and Søborg 2016, 85). Proton suffered from weak product development marketing capability and failed to supply according to market demand – resulting in an export slump in the early 2000s (Natsuda and Thoburn 2014, 1359).

Additionally, Mitsubishi's financial woes prompted it to divest its shares in Proton in 2004 – Proton was in financial chaos (Natsuda and Thoburn 2014, 1359).

By the end of 2005, Proton was straddled with severe financial problems and had to sell its 60 percent stake for one Euro in the debt-ridden Italian motorcycle company MV Augusta acquired in 2004 (Furuoka 2007, 515). The *Economist,* as quoted by Furuoka (2007, 515-516), remarked:

> *Proton has consistently violated every principle of economics and car-making… a firm born of nationalist ideals, not commercial rationale… like its creator, the best thing may be to let it go gently into retirement*

The quote referred to putting Proton to an end just like Mahathir's term as the Malaysian Prime Minister.

After 22 years at the helm of leadership, finally, Dr Mahathir stepped down and was succeeded by Ahmad Badawi (Mohamad 2003, 150, Ismail and Hamid 2013, 74, Pepinsky 2007, 113). The end of the Mahathir era is essential in the narrative to appreciate the policies employed for building innovation capability vis-a-vis the innovation system (Juego 2018, 61). Interestingly, when assessing his failed policies at his retirement, Mahathir categorically pointed out that affirmative policies had led to a *crutch mentality* amongst the Bumiputera businesspeople (Gomez 2012, 67).

Mahathir's retirement statement affirms the argument that the car project's hidden agenda was to promote Bumiputera participation in the industry under the NEP or NDP (Natsuda and Thoburn 2014, 428, Wad and Govindaraju 2011). What was striking was that there was no institutional support available to develop this project – it was institutionally lacking (Wad 2001, 96).

8.2.2 Electrical and Electronics

In an Annual Economic Survey conducted in 2018, the electrical and electronics sub-sector was still identified as having the highest gross output value of 28.4 percent, making it a notable industry within the manufacturing sector (Statistics 2019). Although the sub-sector moved into higher value-added manufacturing, it has not become a global consumer electronic products producer, unlike Taiwanese organisations.

The industry's impetus was the establishment of Matsushita Electric in 1965, when it started with the supply of consumer goods to the domestic markets. In 1971/2, there was the presence of electronics through Clarion and National Semiconductor (Rasiah 2010, 302). By 1980, Malaysian policymakers actively promoted policies and programs to shift Malaysia from a resource-reliant economy to manufacturing. Further, another parallel agenda - intent to increase the participation of ethnic Malays and other indigenous people in the economic development share – arising from the dreadful episode of May 13, 1969, the impetus of NEP, motivated this push. MP1 initiated an FDI-driven manufacturing strategy to shift from resource-based economic activity and import substitution. Consequently, a more-capital intensive manufacturing sector emerged under heavy tariff protections (Narayanan and

Rasiah 1992, 76). The diversification into manufacturing was at an opportune time, given that Japan was aggressively looking for a destination to relocate its integrated circuits production (Yoshino 1974, 371).

Pursuing an FDI-led industrialisation economic growth trajectory resulted in the electrical and electronics industry spearheading the manufacturing sector through low-end assembly manufacturing, introducing an export-oriented strategy (Narayanan and Rasiah 1992, 76). The share of manufacturing to GDP in 20 years increased markedly, mainly in low-end and labour-intensive manufacturing – manual assembly of semiconductors (Lall 1995, 761). Over the years, the products evolved to high-skill and technologically complex products, consequently increasing its high-skill exports to $1.6 billion in 1980 (Lall 1995, 760). However, contrary to the suggestion of early scholars, the high skills that it honed were limited to sophisticated assembly skills, not innovation capability.

A literature survey by Giroud (2000, 4) espoused that the electrical industry relied on the assembly of medium-technology consumer goods and low to medium technology intermediate goods. Further, the primary input factor for the industry was still heavily reliant on imported products, though some secondary ones were locally sourced. Where competition and state-of-the-art technology were involved, these primarily occurred in foreign-owned companies and not local enterprises. This situation was a tell-tale sign of the innovation capability of the workforce in this industry (Giroud 2000). Ariffin and Figueiredo (2004) study on innovation capability in the electrical and electronics industry found that the industry was unlikely to reach a high level of product development and R&D as these activities largely remained in corporate R&D centres of advanced countries. The study recommended that policies be implemented to encourage firms to build innovation capability and ensure locals occupy vital managerial positions in subsidiary companies and assess local technological infrastructure. Post the recommendations in 2004, the changes that may have occurred to bridge the gap identified will be evaluated.

The contribution of the electrical and electronics subsector as an average percentage of real growth for 2011 to 2015, as depicted by **Figure 26,** shows the sector's importance as the forerunner of the manufacturing sector. The policymakers undoubtedly still hold on to this sub-sector as a key for Malaysia to graduate into a high-income country. Further, FDI in this sub-sector is relatively high, as shown in **Figure 27**. This investment corresponds with the export levels achieved by the electrical and electronics sub-sector. These data affirm that Malaysia is still a preferred electrical and electronics production hub destination. However, disturbingly, **Figure 28** provides a snapshot of Malaysia's labour productivity and labour skills and how it stands with the other countries in Asia. Malaysia has a significant catch-up with the developed countries, though it is relatively advanced from the other middle-income and lower-income countries. This situation is welcome, but Malaysia must be aware that if the lower-income countries bridge the gap with labour skills, there is potential for Malaysia to lose its current markets. This is a situation that policymakers should reckon.

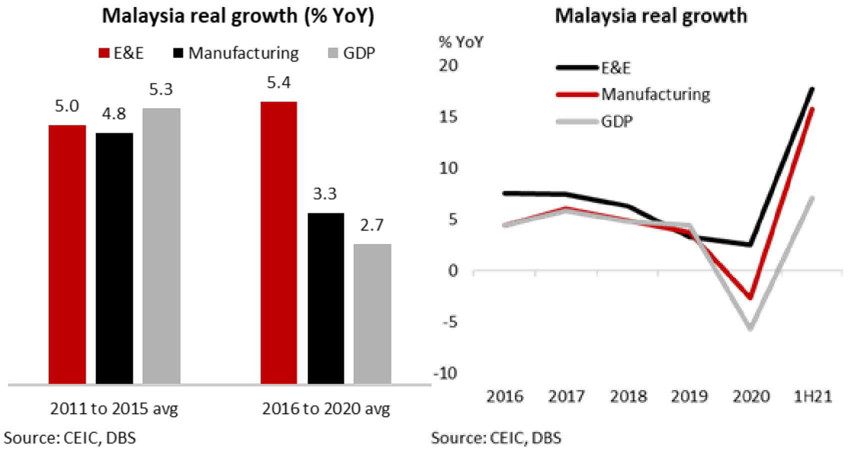


Figure 26 Malaysia Real Growth

Source: Teng (2021)

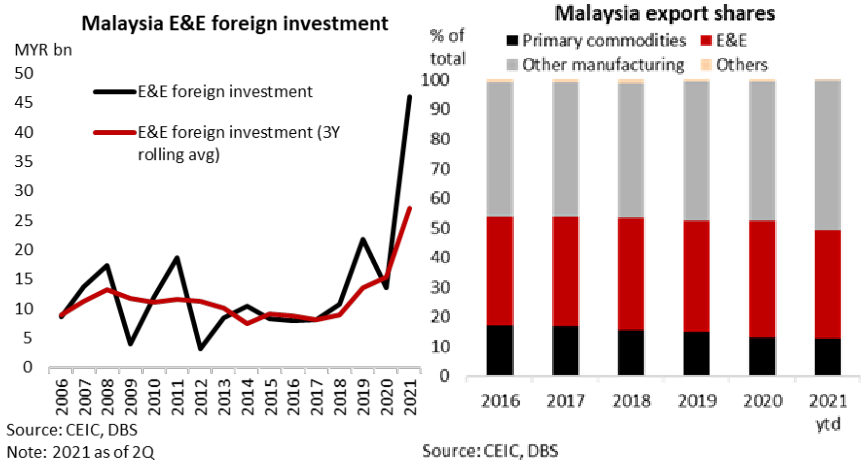


Figure 27 FDI and Export Shares

Source: Teng (2021)

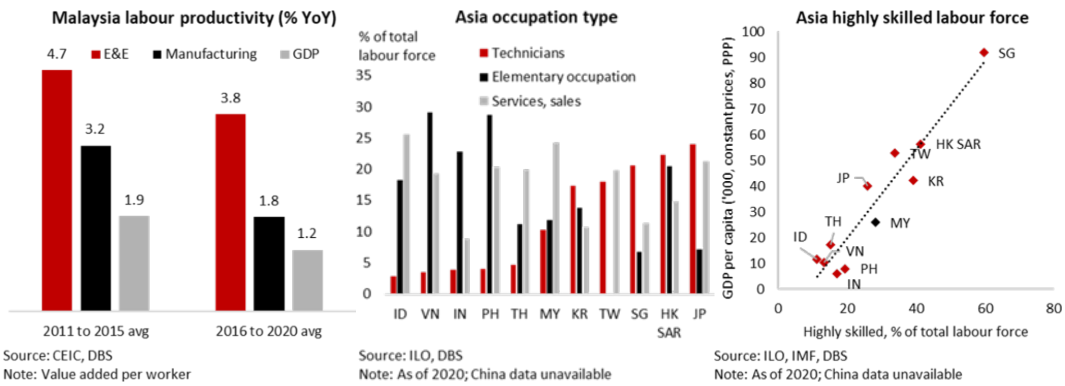


Figure 28 Snapshot of Labour in E&E

Source: Teng (2021)

Although labour productivity in the sub-sector is higher at the country level, it lags internationally. It is striking to note that the number of technicians and a highly skilled workforce are largely lacking. An analysis of this relative lack of skills is undertaken in the coming sections.

8.3 Knowledge Exchange Activities and Skills Development

Taking a cue from the innovative countries as discussed in Chapter 3, there is a need to ensure interaction between the institutions and organisations established, along with monitoring and evaluation to ensure the achievement of economic targets. How the Malaysian policymakers monitored and evaluated their policies and strategies will be undertaken later in this Chapter. University and industry linkages will be analysed in determining the knowledge exchange activities and skills development, mainly related to automotive and electrical and electronics. The success of the industry linkages will be seen in the number of collaborative research undertaken in the period, increases in contract and consultancy research and intellectual property activities, particularly patent registration and commercialisation. Similarly, skills development based on industrial needs will be analysed – this can be elucidated through educational quality and skills developed in meeting the industry demand.

8.3.1 University and Industry Linkages – Collaborative research, contract and consulting research and IP activities

The data obtained from the World Bank indicates that Malaysia's performance in the University-Industry collaboration in R&D (see **Figure 29**) is 4.9 percent average from 2007 to 2018. This figure is comparable to Korea, which has an average of 4.7 percent. It suggests that Malaysia has been able to forge such a linkage. Next, the output in collaborative research, contract research, consultancy research, and IP activities will be explored to appreciate innovation capability development.

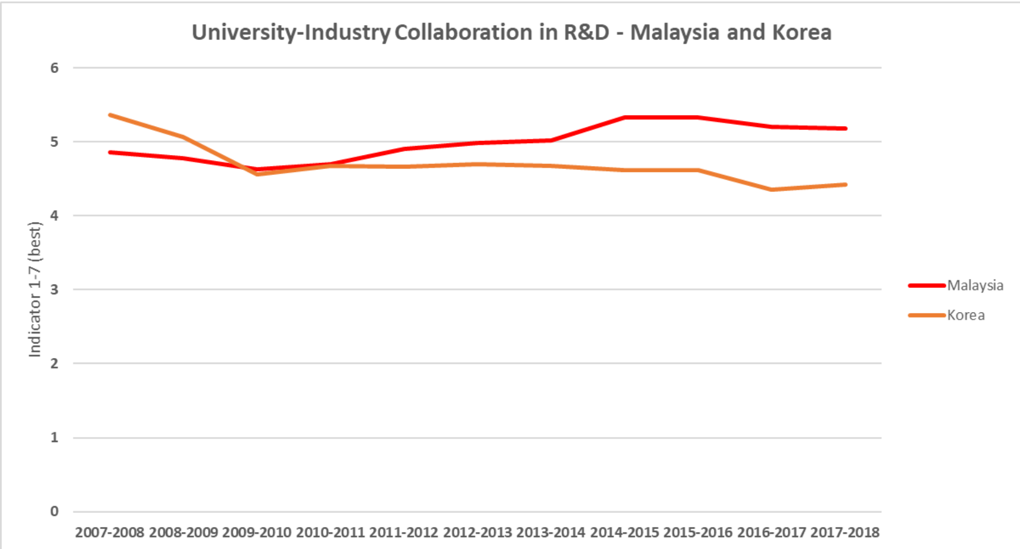


Figure 29 University-Industry Collaboration in R&D
Source: World Economic Forum Global Competitiveness [59]

The University-Industry collaboration was addressed in MP10 (MP10 2011, 223) in the form of Knowledge Transfer Partnership (KTP) discussed in Chapter 7. It was also identified as a National Key Economic Area (NKEA). The National Higher Education Action Plan

[59] http://reports.weforum.org/global-competitiveness-index//

2011-2015, a document prepared by the Ministry of Education, provided updates on consultation project outputs achieved in 2010. Accordingly, RM119,008,933.22 was achieved, which was higher than in 2009 (value not mentioned)(Education 2011, 48). Interestingly, in the Malaysia Education Blueprint issued in 2015, it was noted that collaborative research in Engineering, Science and Technology (CREST) had been lacking due to a lack of confidence in the R&D capabilities in academia. In order to bridge this gap, the Malaysian policymakers introduced the CREST programme launched in 2012 and the Public-Private Research Network (PPRN) in 2014 to encourage collaboration (Malaysia 2015, 7-11). CREST and PPRN were mentioned briefly in MP11 (2016, 3-31, 8-32) though it was created prior and not mentioned in MP10. This programme intended to boost R&D in the Electrical and Electronics industry, with a total of RM14.2 million available in grants (Malaysia 2015, 7-11). A newsletter by CREST mentioned that the program resulted in 17 implemented projects and 21 intellectual property applications filed, and seven were granted (CREST 2020, 4). The commercialisation rate of R&D outputs by the institution of higher learning (IHL) is shown in **Table 63.**

Commercialisation rate of R&D outputs	2010	2012/13	2020 (target)
IHLs (%)	3.4	2.1	5.0

Table 63 Commercialisation rate of R&D outputs, 2010 -2020 (target)
Source: MP11 (2016, 8-31)

The data alone is not explanatory as there were no prior data available for comparison purposes. However, just in comparison between the years mentioned, it is suggestive that the rates achieved in 2012/13, which declined by 1.3%, is quite substantial, and the target may be a difficult feat to be achieved.

No data was available from the Malaysia Plans or other sources on the reporting structure of CREST since it was a non-governmental organisation. However, the Ministry of Science, Technology and Innovation (MOSTI) reports its projects and grants.

There was no evidence available from the plans on contract and consultancy research. Although it may exist, these could not be discerned. The IP activities, as discussed above, is the only evidence that can be obtained on this collaborative exercise. This dedicated approach for Electrical and Electronics has been the first in the many years of planning and still lacks concrete collaborative evidence for the automotive industry.

8.3.2 Industry Needs and Skills Development

The investment in education is essential since it involves the supply-side to create an innovation system. According to the demand for a technically sound workforce, the supply is the driver for an innovative and inventive workforce. Evidently, Malaysian policymakers have invested substantially in developing education and skills as early as MP1. Meeting the demand for a skilled workforce is crucial to ensure a sufficient supply of a technically sound workforce is available to the industry. The coming discussions will analyse (1) educational quality and (2) technical skills development according to industry standards.

8.3.2.1 Educational Quality

Before considering specific initiatives taken by the Malaysian policymakers in the last thirty years, an observation worthy of mention is that all the 11 Malaysia Plans have repeatedly reiterated the shortage of qualified workforce. Given that Malaysia spends about five percent of its GDP on education, above those of the East Asian countries, it is surprising that it has not bridged the supply gap for a technically qualified workforce. This outcome is alarming since the shortage persisted even in 2016, prompting the question of why the education policies have failed in creating the feeder required by the industry.

The analysis of the plans finds no evidence of alignment between economic and educational policy, strategies or programs. This thesis postulates that an adequate workforce with the required capability will be produced if educational and skills development policies or programs are aligned. This inference is drawn from the Korean strategy, which launched a series of economic changes closely tied to educational goals (Ilon 2011, 656). The following table summarises the approach taken by Korea and Malaysia, respectively.

PERIOD	EDUCATION PROGRAM	ECONOMIC POLICY
1960-1970	Expand access to secondary education and improve primary schooling	Cater for import substitution, which was labour intensive
1970 – 1980	Upper secondary expanded, tertiary education and technical and vocational	Innovation and leadership development
1990	Education emphasis was on quality	Knowledge-based economy

Table 64 Educational Program aligned to Economic Policy, Korea

Source: Extracted from Ilon (2011, 656)

PERIOD	EDUCATION PROGRAM	ECONOMIC POLICY
1970 – 1980	Expand and improve the education system and narrow the inter-ethnic gap and promote national unity	Labour intensive – import substitution
1980 – 2006	Expand education, entry for indigenous Malay to move into the modern sector, promote national unity and move into science and technology	Heavy industry and labour intensive
2006 – 2020	Promote national unity, improve quality, and emphasise skills development and technical and vocational education.	High technology and Knowledge economy

Table 65 Educational Program aligned to Economic Policy, Malaysia.
Source: Summarised and Analysed by the author from the Malaysia Plans

What is evident from **Table 65** is that the education policy had continuously promoted national unity and accessibility, which was a NEP/NDP driven recurrent policy consideration. This misalignment needs to be addressed as innovative countries align education policy with the economic plan – which is missing in the Malaysian context.

Further, there is a correlation between quality and innovation capability. There is evidence from the plans to support the claim that Malaysian policymakers have regularly promoted quality education. This strategy was prevalent in MP10 when it embarked on reforming the education system to ramp up student performance to reach international standards. The Education Blueprint was launched in 2013 to transform the education system by 2025. One of the key outcomes was to improve the PISA[60] and TIMMS[61] assessment achievements. PISA is a triennial survey conducted by the OECD to evaluate 15-year-olds' knowledge and skills in reading, mathematics, science, and global competence[62] (Chin 2019). TIMMS,

60 Program for International Student Assessment organised by OECD
61 Trends in International Mathematics and Science Study
62 OECD introduced this additional component in 2018

conducted by the International Association for the Evaluation of Educational Achievement (IEA), is an international assessment of student achievement in mathematics and science in fourth and eighth grades.

Accordingly, the Education Performance and Delivery Unit (PADU) was formed in 2013 under the Ministry of Education (MP11 2016, 5-9) to monitor the progress of the outcomes. A quick check of the most recent PISA survey results revealed that Malaysian students' performance was still below OECD countries, though on an increasing trend. The figures below summarise the results of Malaysian students in the PISA.

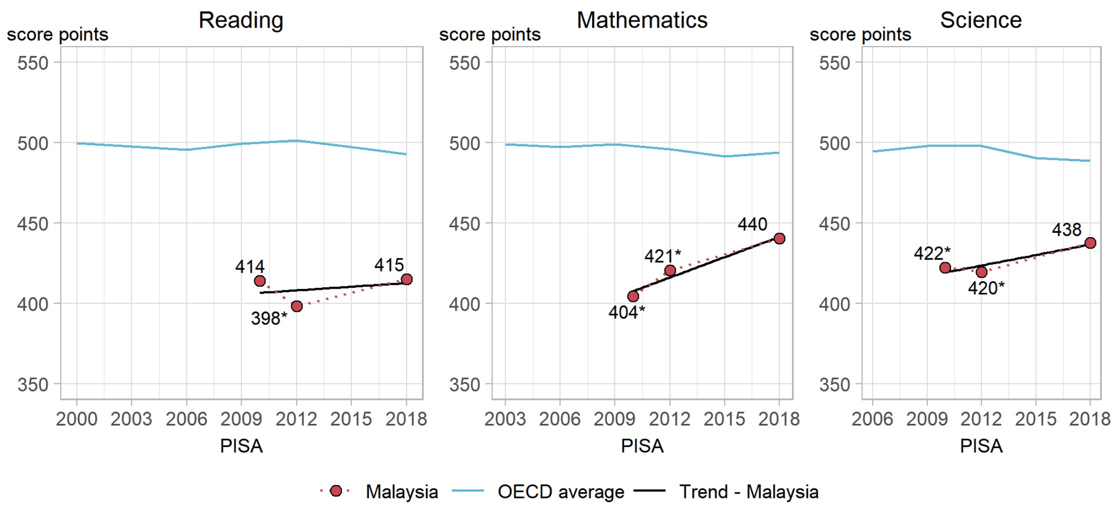


Figure 30 PISA Results for Malaysian Students

Source: OECD, PISA 2018 Database

Notes: ∗indicates mean-performance estimates that are statistically significantly above or below PISA 2018 estimates for Malaysia. The blue line indicates the average mean performance across OECD countries with valid data in all PISA assessments. The red dotted line indicates mean performance in Malaysia. The black line represents a trend line for Malaysia (line of best fit).

PADU failed to report this finding in its report card on the Blueprint's progress (PADU 2018), despite being a critical outcome. Based on these discussions, the conclusion is that initiatives were introduced without any economic development alignment, and policies, strategies or programs are not closely monitored and evaluated — suggesting a breakdown in the innovation system.

As highlighted in the earlier chapters, the influence of Japan was prevalent, and this was amplified when the Malaysian policymakers attempted to emulate the moral and ethical values of its workforce. This agenda was pushed through education policies by Mahathir Mohamad, who was enamoured with the Japanese work ethic (Furuoka 2005, 4, Lee 2017, 156, Mauzy and Milne 1983, 624). He had openly expressed his admiration and desire to emulate this work ethic on many occasions. Furuoka (2005) quoted that "*matters deserving attention were diligence and discipline in work, loyalty to the nation and the enterprise or business where the worker is employed, and the priority of group over individual interests*" (4). Further, following the LEP, in MP5, the Malaysian policymakers encouraged on-the-job training with Japanese and South Korean firms to learn and acquire discipline and work ethics (MP5 1985, 495). It is evident that the Malaysian policymakers equated this work ethic to economic success and continuously promoted this agenda. This approach is deep-rooted, as evidenced by the excerpts containing texts on ethical and moral considerations from MP3 through to MP11 summarised below.

Malaysia Plan	Program
MP3	the development of personality, character and good citizenship and the promotion of moral discipline through the curriculum and extra-curriculum activities (391)
MP4	The main objective of religious and moral education and ethics is to build a solid basis for developing a disciplined society with high moral values. (237)

MP5	Curriculum and co-curricular activities will be the means to inculcate good qualities, leadership capabilities, and strong moral values, while efforts will continue to be made to narrow the gap in educational opportunities among income groups and regions by expanding and improving educational facilities throughout the country (497)
MP6	education and training programs were further expanded and improved, not only to equip individuals with the appropriate knowledge and skills but also to produce responsible citizens with strong moral and ethical values (157)
MP7	the objective of education and skill training programs will be to produce an adequate number of skilled and quality workforce to meet the workforce requirements of the country and produce citizens who are disciplined and possess high moral values and good work ethics. (321)
MP8	With the development of a knowledge-based economy, knowledge acquisition, utilisation, dissemination, and management will be more liberal and can be abused. To counter such influences, Malaysians must be inculcated with positive values from young. This can be achieved by incorporating civics education in moral or religious education curriculum. (117)
MP9	At the same time, there is a need to strengthen the overall mindset, culture, values and social institutions to be more in step with the country's economic development. There is a danger of the country possessing first-class infrastructure but a third-class mentality. In order to pursue further growth and development, Malaysia will need to fortify its moral and ethical foundations while enhancing its mindset and attitudes towards excellence and performance. (4) Programs to develop a moral and ethical society will be made an integral and critical part at all levels of development planning to complement the physical development programs as well as enhance national unity. In this regard, values of tolerance and moderation, as well as a sense of belonging and pride in the nation, which are crucial in a multi-racial country, will be given emphasis. (259)
MP10	Nurturing a system based on integrity and moral values. The National Integrity The plan has an essential role in cultivating a society that adheres to the highest ethical and moral standards and is vital in religious and spiritual values. Towards this end, the Tekad Integriti action plan will be introduced as an enhancement to Tekad 2008. (128)
MP11	The quality of education will be raised to develop talent with both the knowledge and skills and ethics and morality, to thrive in a globally competitive and dynamic environment. (1-9) To realise this, Malaysia will require human capital with knowledge and skills, as well as ethics and morality, to drive inclusive and sustainable economic growth (5-15) The government aims to produce future leaders with the knowledge and skills, and ethics and morality, that will propel Malaysia to even greater heights. (5-25)

Table 66 Compilation of measures promoting moral and ethical values

Source: Compiled by the researcher from the various Malaysian Plans

Whilst policy measures can change economic structure; it is doubtful that they will change cultural and societal norms. Hence, this thesis posits that such an agenda cannot produce an innovative workforce(Gomez-Salvador et al. 2006, 5).

8.3.2.2 Technical Skills development according to Industry Standards

On evaluating the supply of a qualified workforce, when the shift into heavy industry occurred, corresponding to the periods of MP1 to MP4, the analysis finds a shortage of skilled technical and professional workers. This shortage was described in Chapter 6, and the excerpts are provided in **Table 67**.

Malaysia Plan	Technical Development
MP1	Identified that personnel required to implement projects were in short supply, and training to overcome the shortages were undertaken (MP1 1966, 11). In the interim external technical expertise were used (MP1 1966, 14). Expansion in vocational, technical and higher education will produce workforce which will only be available after 1970(MP1 1966, 84).
MP2	A shortfall existed in the vocational and technical education program due to inadequate implementation capacity, shortage of teaching staff, and obtaining foreign financing (MP2 1971, 29). Strong emphasis was given to science, technical and vocational education (MP2 1971, 73). The strong demand for skilled blue-collar workers was expected to continue during MP2, and the strategy was to orient the education system towards science and technology (MP2 1971, 107).
MP3	A sizeable number of scientific and technical personnel were needed between 1975 and 1990 (MP3 1976a, 70, 154). A constraint in accelerating socio-economic development is the shortage of trained manpower at all levels in the science and technical fields (MP3 1976a, 138). There will be critical shortages of technical and scientific personnel at the degree and diploma levels, and it is pressing in the engineering fields (MP3 1976a, 155, 267).

MP4	With the structural transformation towards industrialisation, a greater demand for scientific, technical, managerial, and skilled production workers will exist (MP4 1981, 143).

Table 67 A summary of shortage of technical and skilled workforce, MP1-MP4

Source: Compiled by the researcher from the various Malaysian Plans

The industrialisation strategy has been motioned through car manufacturing with a shortage of skilled labour. Although shortages per se are not sufficient to affect innovation, it will hamper the innovation absorptive capability of the workforce, hindering any meaningful technology transfer.

An analysis of the policies for the general approach to education and technical and vocational training during MP1 to MP4 **(Table 68 and 69)** does not reveal a dedicated alignment of developing automotive or electronic and electrical industry capability or for forward and backward linkage to these industries.

Malaysia Plans	Educational or Skills Training
MP1	Emphasis on general education with a vocational or technical emphasis on industrial arts, science, commercial studies and home science (MP1 1966, 167). No specific mention was made on automotive or electrical engineering.
MP2	Through its vocational institute, the Training Division of MARA provided courses on mechanical and automobile engineering (MP2 1971, 229-230). The Industrial Training Institute (ITI) offered courses in mechanical and electrical engineering (MP2 1971, 229). Science Education Centre was formed to improve the curriculum and teaching of science and mathematics (MP2 1971, 238).
MP3	ITI offered automotive and engineering trades (MP3 1976a, 396). Politeknik Ungku Omar provided training in electrical and mechanical engineering among others (MP3 1976a, 387). The teaching of science and mathematics will be strengthened (MP3 1976a, 398).

MP4	Institut Kemahiran conducted courses ranging from electrical and automotive among others (MP4 1981, 241). Practical courses in science, engineering and technical areas will be increased (MP4 1981, 240).

Table 68 Approach to Education and Technical and Vocational Training, MP1-4

Source: Source: Compiled by the researcher from the various Malaysian Plans

Education	MP1	MP2	MP3	MP4
Program / Strategy	Intensify and expand the development of human resources (162)	Emphasis was given to science, technical and vocational education and upgrading and expansion of educational facilities in rural areas (73)	Orientate and expand education and training to meet national workforce needs, particularly in science and technology (391)	Increase efficiency in meeting workforce requirements (236)
	Diversify education and training in vital areas, i.e. agricultural and industrial science and technology	To fill the demand for high-level and trained manpower (97)	Increasing effectiveness of training programs through assessment of skill demands and evaluation of curricula, training standards and job experience of graduates (396)	Higher education is geared towards increasing the output of trained and skilled manpower (239)
		Train both locally and abroad high-level and skilled manpower in agricultural research and extension programs, engineering and related skills, trained teachers, health workers and managerial personnel (105)		Increase practical training in science, engineering and technical courses (239)
		Increase capacity of institutions to train engineering and technical personnel (106)		
Vocational / Technical	Polytechnics were planned to offer chemical, rubber, food, aeronautical and motor technologies (169)	To mobilise indigenous Malays into the industrial sector, MARA Vocational Schools, MARA Institute of Technology, the Ministry of Labour and Manpower and the National Productivity Centre was formed (160). General vocational stream shift was proposed (223)	Implementation of vocational training programs was a priority (395)	Therefore, general education and vocational were streamed (238). Trades focused were tool and dye making, foundry practice, welding, refrigeration and air conditioning, architectural and structural drafting (238).

Table 69 Education and Vocational Strategies and Programs – MP1-MP4

Source: Compiled by the author

Although Technical Education and Vocational Training (TEVT) were aggressively promoted, it did not produce a sufficient technically qualified workforce to fulfil industry requirements. Concentration on vocational studies has existed since MP1. What is worth mentioning is that MP1 stated *…expansion in vocational, technical, and higher education will produce graduates in numbers approaching demand … after 1970* (MP1 1966, 84). MP1 was forward-thinking and planned to have a sufficient number of technically qualified workforce for the fields of agriculture, industry and commerce (MP1 1966, 168). MP2 reported that the inadequate implementation capacity, shortage of teaching staff and insufficient funding affected vocational education (MP2 1971, 29).

It was during MP5 that vocational studies were promoted as mainstream education. However, this push was closely linked with the NEP agenda of encouraging the entry of Bumiputera Malays into modern industry instead of building a qualified workforce. This agenda was political as opposed to economic. The promotion of technical and educational studies continued in MP6 and MP7 with new specialisations and facilities; however, evidence of alignment with developmental goals was still lacking. A further observation gleaned from the plans was the complex and complicated organisational structure introduced to drive and manage vocational streams, as discussed in Chapter 7. The lack of alignment was prevalent and continued through to MP9 (MP9 2006, 248).

The efforts invested in MP8 and MP9 resulted in an average enrolment growth of 10 per cent compared to 44 per cent in OECD countries, as reported in MP10. Hence, MP10 devised strategies to promote TEVT programs to increase enrolments (MP10 2011, 216) to fill 60 per cent of the 1.5 million jobs created (MP11 2016, 5-21). Despite the measures in MP10, MP11 reported that the projected annual intake required by 2020 was 225,000, yet to be achieved (MP11 2016, 5-21). The report by PADU on graduates, revealed an increase from 12,803 in 2017 to 13,740 in 2018, about 7.31 percent (PADU 2018); However, these were lower than projected by MP11. In sum, by evaluating the plans on the development of vocational education in Malaysia, it is concluded that they lacked focus and alignment between vocational development and structural transitions. This finding corroborates the literature, which states that if the actors within the system are not aligned, economic growth will be elusive.

A skilled workforce is essential to becoming a developed country, and **Figure 31** indicates a gap that needs to be addressed to achieve the target by 2024[63]. How the other East Asian countries have addressed this issue will be interesting, particularly Korea, since it produces the highest number of technicians per million people, i.e. an average of 820 technicians, which is way higher even than Japan.

[63] Revised target

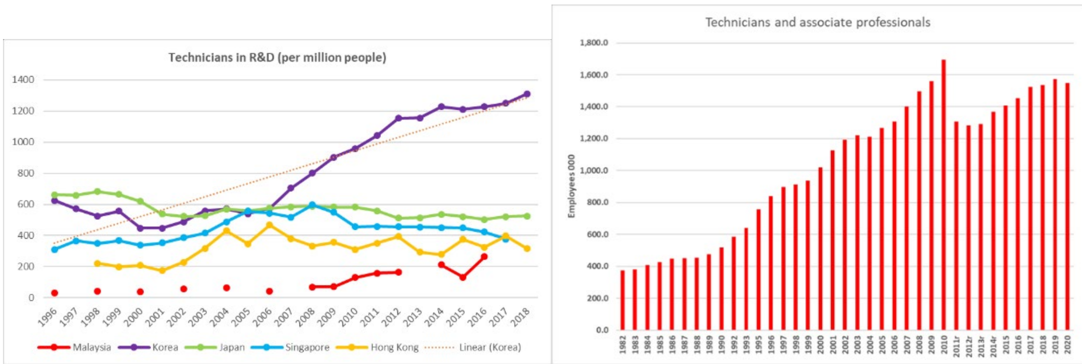


Figure 31 Number of Technicians in R&D of Malaysia and the East Asian Countries

Source: Statistics (2020)

When drilled down further to obtain an idea of the number of engineers developed throughout 2011 and 2019, there has been a steady increase in the number of engineers registered and within the areas electrical and electronics records about 25.4 percent. The number of registered engineers is promising, and when compared to Korea in the same period, it records 61,006 registered engineers, about 11 percent higher than Malaysia. When diving deeper, the automotive sector does not seem to display any significant numbers of registered engineers.

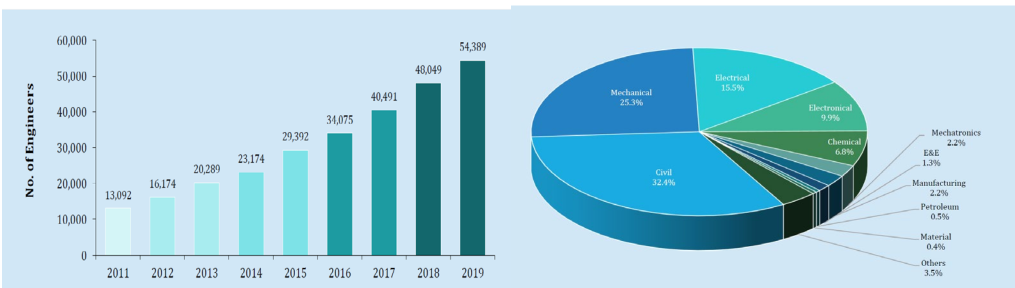


Figure 32 Number of Registers Engineers and by Field, 2011-2019

Source: Ministry of Science (2020, 125-126)

In a similar vein, the analysis drilled down to the number of technicians according to the sectors, and it can be seen that the electrical and electronics technology technicians are leading the pack with the highest number of technicians. This situation is promising for the industry that has been earmarked as the forerunner of the manufacturing sector. However, automotive technology numbers are far lesser and may not be able to service the sub-sector effectively.

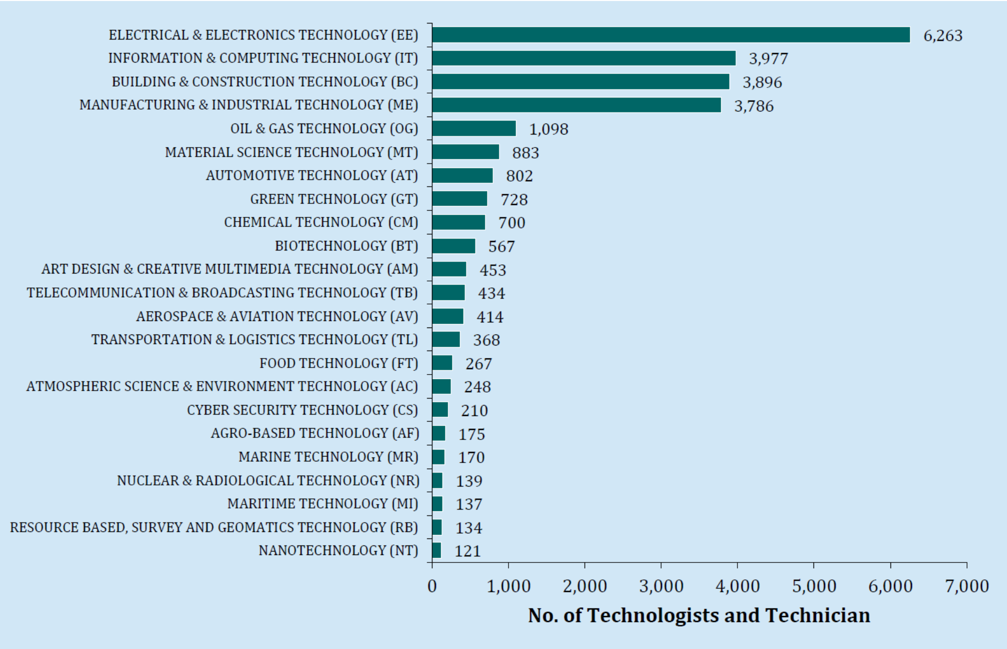


Figure 33 No of Technologists and Technicians as of Nov 2020

Source: Ministry of Science (2020, 127)

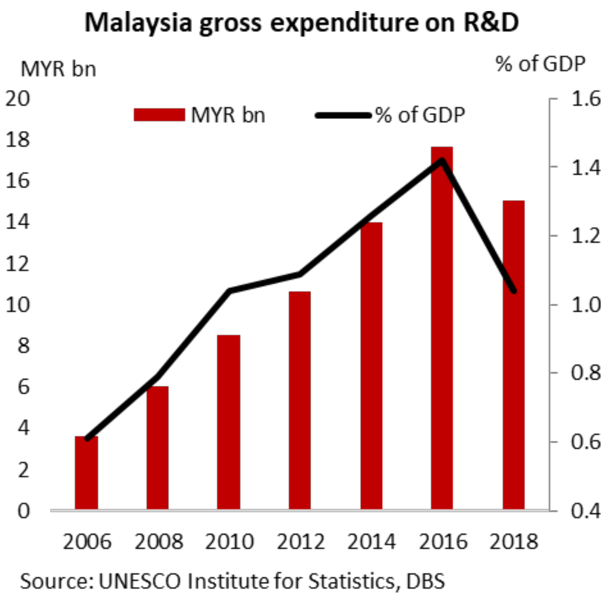
A further search on skills development revealed that MIMOS, established in MP5 as discussed in Chapter 6, was tasked to conduct microelectronics research and provided training under its Skills Development Programme. Accordingly, its 2020 report indicated that 3,731 engineers, lecturers, and students benefited from this training. It also trained 580 graduates under its Post-School Finishing Programme (PSF) in collaboration with the Ministry of International Trade and Industry (MITI), Malaysian Investment Development Authority (MIDA) and Ministry of Education (MOE) (MIMOS 2020, 20).

8.3.4 R&D activities and Innovation

8.3.4.1 R&D (total/business)

The GERD data (**Figure 34**) indicates Malaysia invests the lowest compared to the developed countries except for China which invests double of Malaysia. Comparatively, the investment by the Korean government surpasses the other countries and has been seen to be yielding the output as required, i.e. increased number of researchers in R&D. This achievement is further evident in the research outputs and citation besides patents registered by residents.

At the national level, the investment as a percentage of the GDP has sharply declined from 2016 onwards. Given the desire to become a developed nation and taking the cue from those at the top of the echelon, Malaysia should invest more.



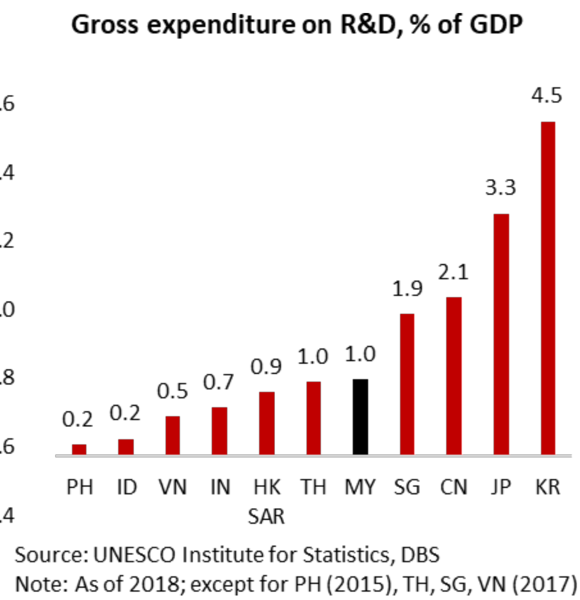


Figure 34 GERD

Source: Teng (2021)

When drilling down the R&D expenditure by sectors **Figure 35** indicates that Business enterprise investment is the highest, followed by Higher Education Institutes. Interestingly, public research organisations do not spend much on R&D, although there was a spike in 2015. Before 2010, BERD was relatively higher than GERD, but it has significantly reduced. This phenomenon is interesting. It is postulated that the lack of confidence in the innovation capability of the Malaysian workforce could have contributed to this turn of events, amongst other factors. However, there seems to be an increasing trend, which may need to be investigated further.

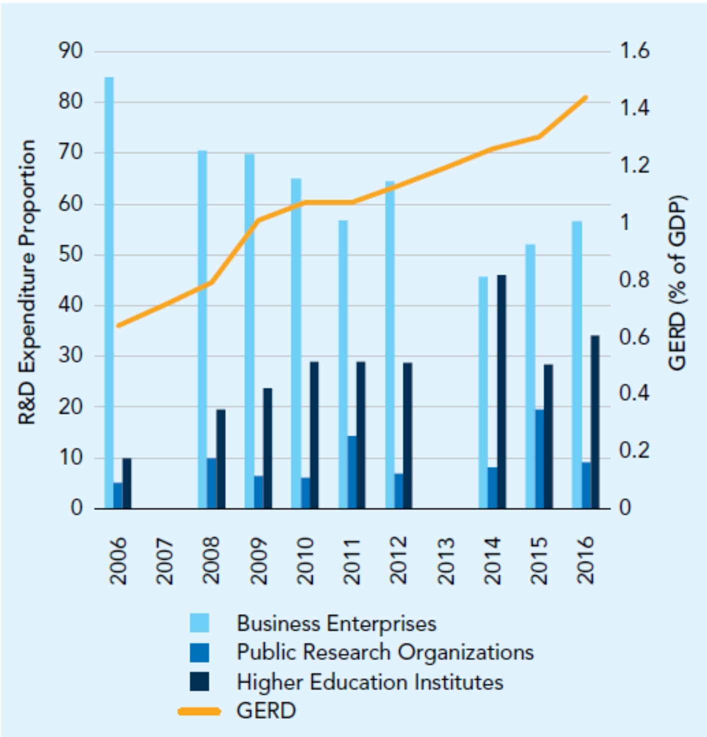


Figure 35 Proportion of R&D Expenditure by sector and GERD %GDP
Source: Worldbank (2020, 27)

The below snapshot of the activities that the GERD is expended on suggests that it invests about 36.3 percent in engineering and technology, which may be assumed to contribute to the electrical and electronics and the automotive industry. Whether this is sufficient, and the quality of the investment need to be investigated.

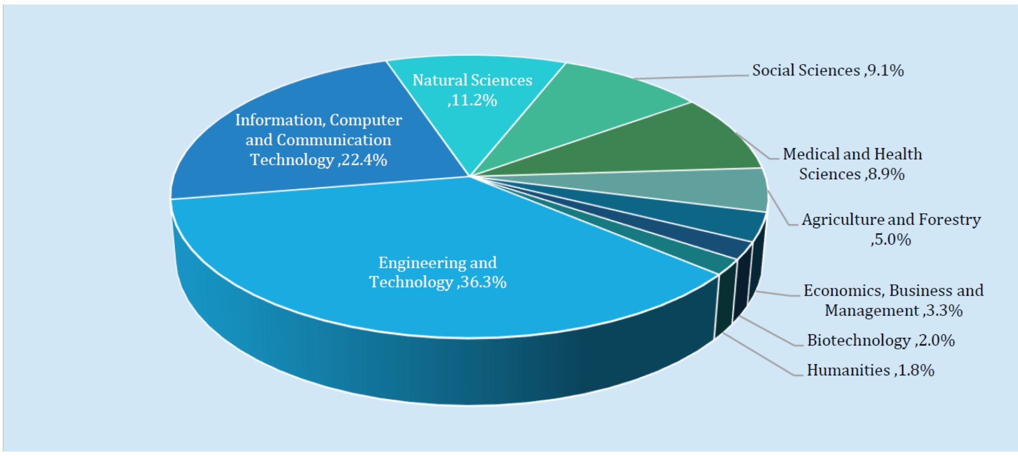


Figure 36 GERD by Activities, 2018

Source: Ministry of Science (2020, 116)

Looking further into **Figure 36**, it reveals that only 15.1 percent of business enterprises engaged with R&D activities in the manufacturing sector. Although the investments were higher, the numbers of business entities were relatively few and possibly foreign-owned.

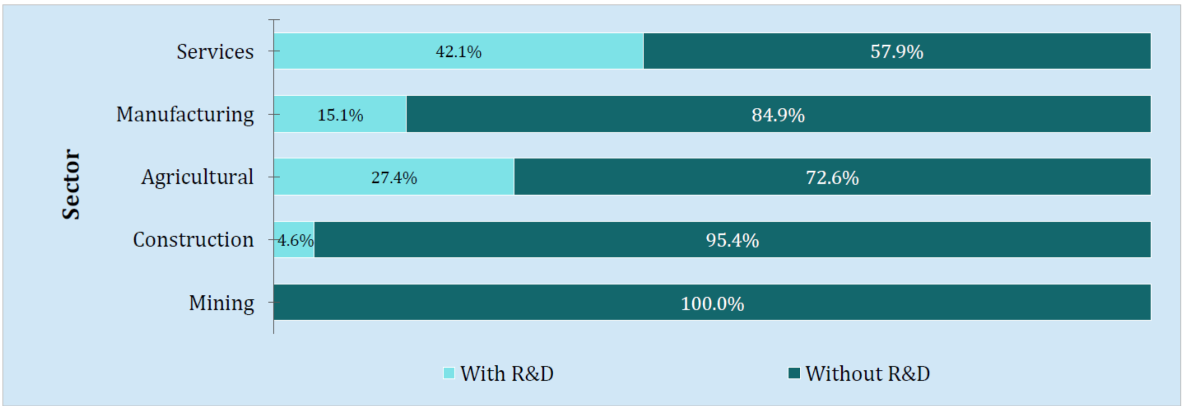


Figure 37 Business Enterprise with R&D activities by economic sector 2018

Source: Ministry of Science (2020, 120)

Additionally, this small number of business enterprises contributed to 50.1 percent of BERD. This snapshot is a worrying trend as the majority of the business enterprises are not engaged with R&D and therefore will not have the innovation capability. Whereas the few that do invest are foreign-owned, it will greatly impact the Malaysian economy when relocation occurs.

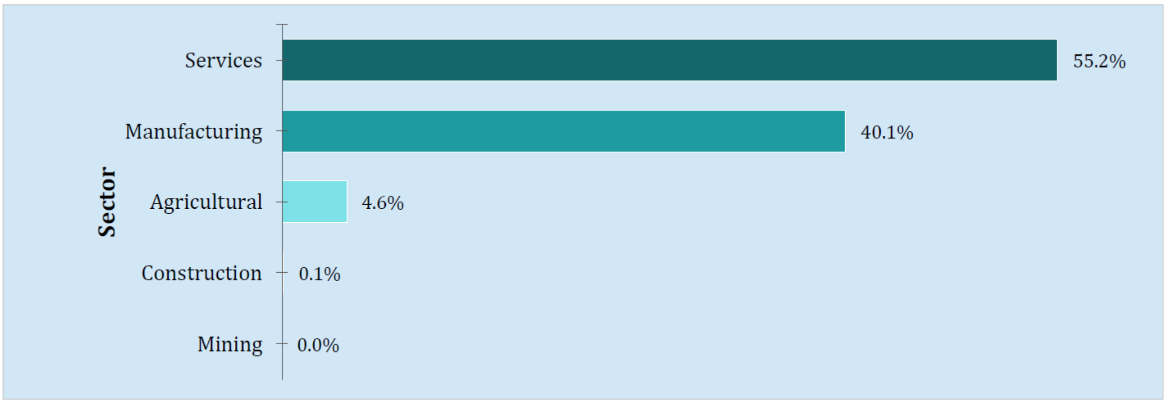


Figure 38 BERD by Economic Sector (%) 2018

Source: Ministry of Science (2020, 121)

8.3.4.2 Scientific Publications

Figure 39 provides a snapshot of Malaysia and Korea's scientific and technical article generation. As indicated by this figure, there appears to be a huge gap that needs to be bridged by Malaysia to attain the level of Korea. However, in **Figure 40**, the citations of international science and engineering articles, the difference is not as massive, although Korea has recently surpassed Malaysia. However, the statistics provided here is that as of 2014, so there is a need to obtain the latest data to confirm the situation.

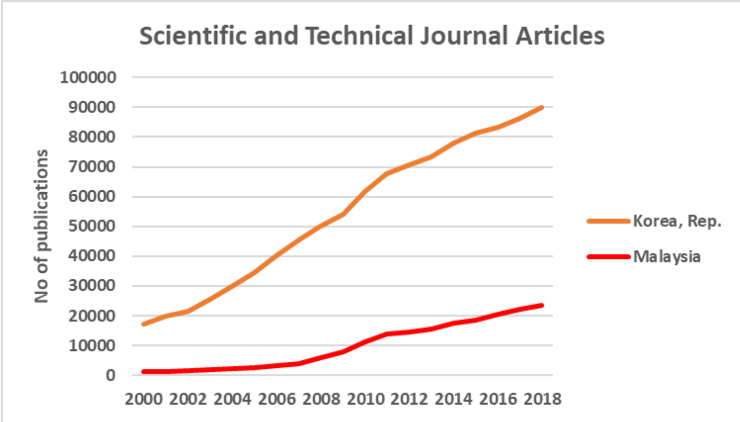


Figure 39 Scientific and Technical Journal Articles Output

Source: Worldbank Data[64]

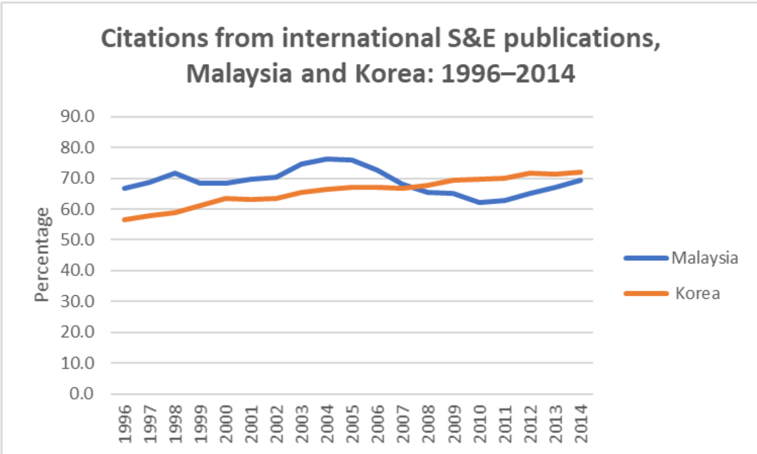


Figure 40 Citations from International Science and Engineering publications, Malaysia and Korea: 1996-2014

Source: Board (2018)

At a national level, the growth of publication output has slowed down, particularly from 2012. There are signs of improving trends, but they do not seem to reach the levels prior to 2012. This situation could be explained by the brain drain over the past, with many Malaysians migrating. This situation, if persisting, may witness a loss of the knowledge workforce. This situation was acknowledged in MP10 and

[64] https://data.worldbank.org/indicator/IP.JRN.ARTC.SC?locations=MY-KR

MP11, where programmes to retain experts and bring back Malaysians abroad were launched.

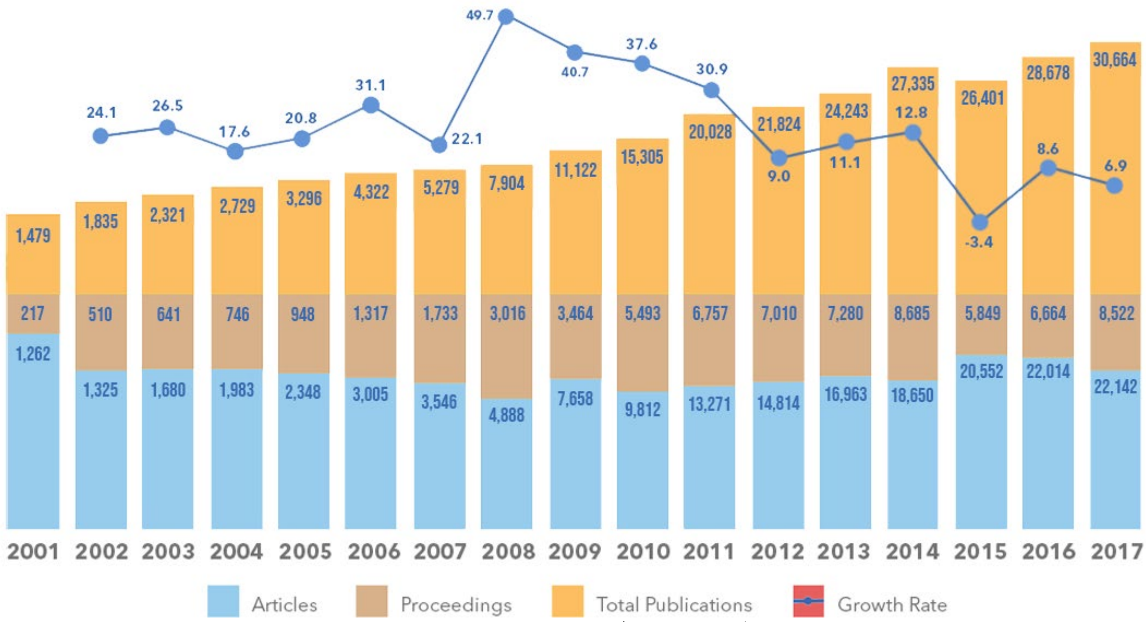


Figure 41 Malaysia's Yearly Publication Output and Growth Rate (2001-2017)
Source: Ministry of Energy (2018, 7)

Of the publications produced, about 40,349 articles are in engineering and incidentally the most significant contributor to the output. Out of this number, about 5,275 articles related to electrical and electronics (Ministry of Energy 2018, 11-12). None were mentioned for automotive engineering.

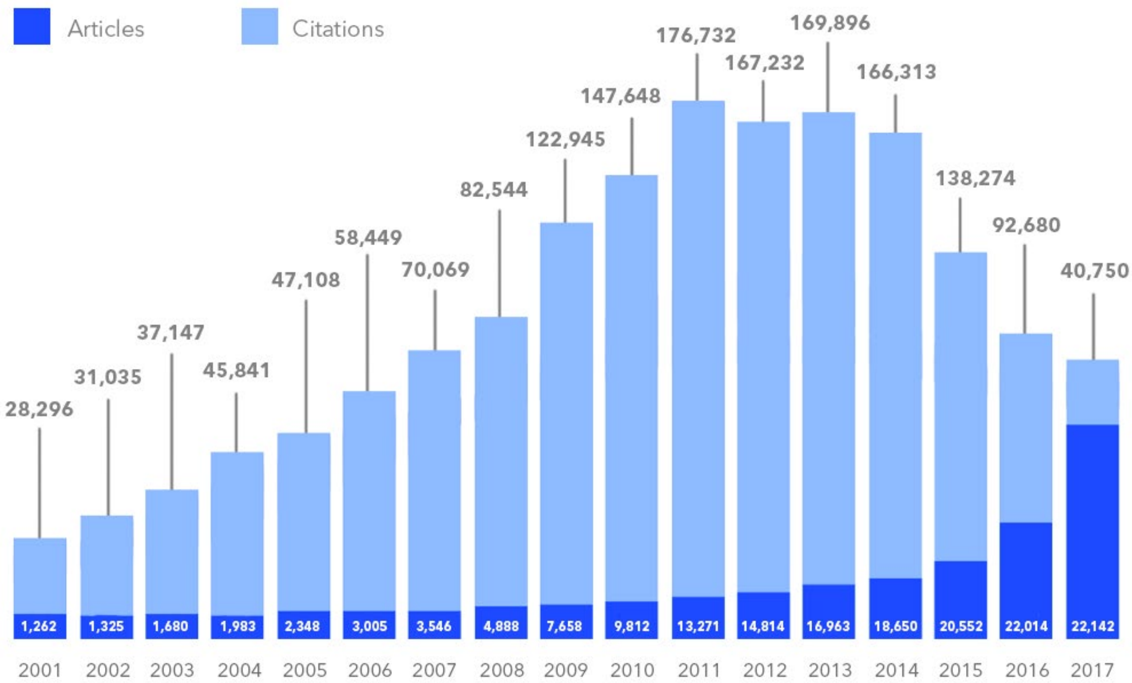


Figure 42 Yearly article and citations, Malaysia, Scopus (2001-2017)

Source: Ministry of Energy (2018)

8.3.4.3 Patents

Another output that needs to be considered is patent applications and grants. **Figure 43** indicates the number of applications made from 2006 to 2019. As can be seen, the number of non-residents applying for patents far supersedes the resident application. This situation suggests that the residents lack the innovative capability or there is just no interest in R&D. As indicated in the discussion above, through the lens of BERD, the majority of local businesses are small and may not have the resources to embark on patent protections.

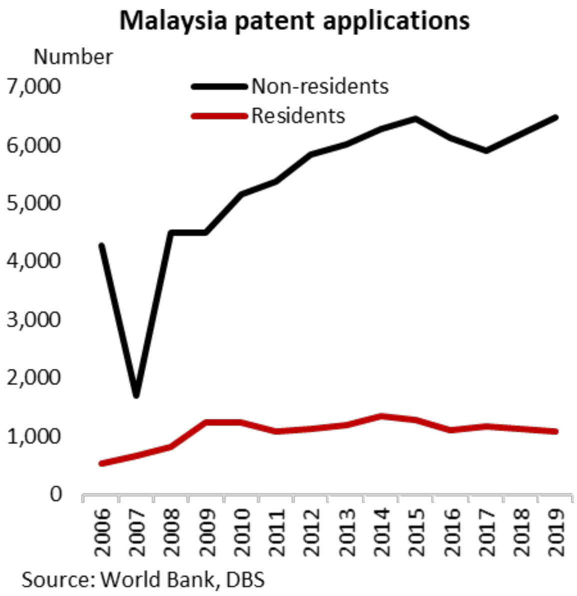


Figure 43 Malaysia Patent Application 2006-2019

Source: Teng (2021)

Additionally, MIMOS, the country's Applied Research and Development Centre, an agency under the Ministry of Science, Technology and Innovation (MOSTI), reported its cumulative patent applications from 2006 to 2020 as per **Table 9.** From the data, it can be discerned that its local applications were higher than international ones, corresponding to the grant and commercialisation. However, the international applications are lower than the local, and interestingly, there is no reporting on the number granted to MIMOS. This situation suggests that most of the resident applications indicated in **Figure 43** originate from this government agency.

Cumulative Patents (2006-2020)	
Patents filed with MyIPO (local)	1,376
Commercialised Ips	640
Patents Granted	653
Patents filed with the Patent Cooperation Treaty (International)	959

Table 70 Cumulative Patents (2006-2020) by MIMOS

Source: MIMOS (2020, 22)

When comparing this situation with Korea **(Figure 44)**, the resident applications are way higher than Malaysia's. This situation provides a synopsis of Malaysia's extent to migrate into developed nation status.

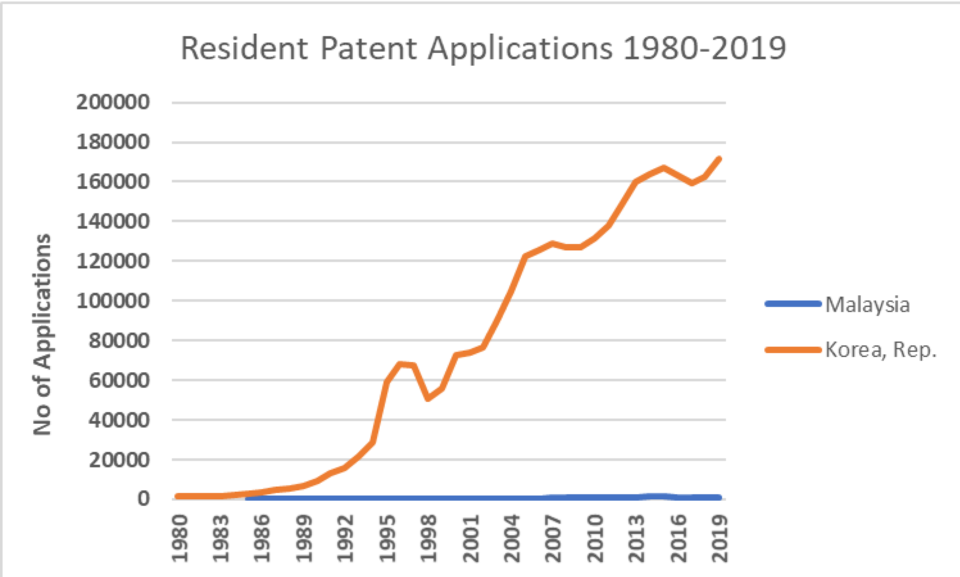


Figure 44 Resident Patent Applications, 1960-2019

Source: WorldBank Data[65]

[65] https://data.worldbank.org/indicator/IP.PAT.RESD?locations=MY-KR

8.4 Monitoring, Evaluation and Correction

Having discussed all the outputs, it becomes essential to discuss how the Malaysian policymakers monitored, evaluated and corrected the National Innovation System. As alluded to in Chapter 6, the National Development Planning Committee (NDPC) was established to plan and coordinate economic and social programs. It was tasked with the development and monitoring planning process and mechanism. *Figure 20* elaborates its planning and monitoring structure. The National Economic Action Council (NEAC) was established in 1998 and was not mentioned in the Malaysia Plans. Its formation responded to the 1997 Asian Financial crisis (Mustapa and Jeffrey 2002).

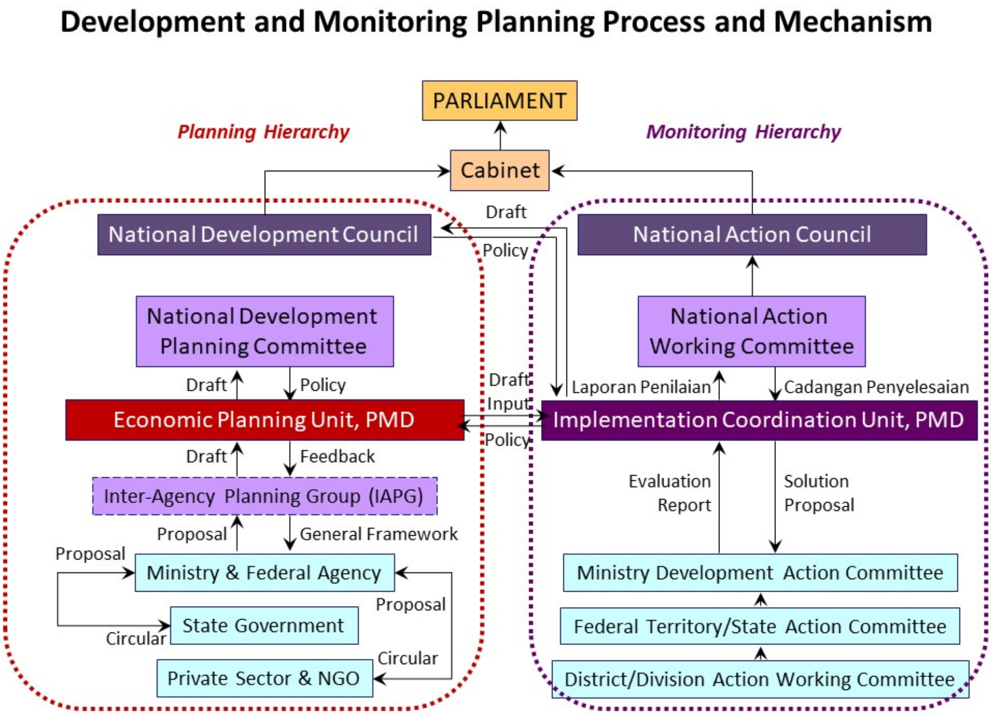


Figure 45 Development and monitoring planning process and mechanism

Source: Official Portal of Economic Planning Unit, Pri*me Minister's Department*[66]

[66] https://www.epu.gov.my/en/economic-developments/economic-management/development-and-monitoring-planning-process-and-mechanism#:~:text=Economic%20Management,-A%20Brief%20History&text=Parliament%20is%20the%20highest%20level%20in%20national%20d

However, in the preceding discussions, it was evident that this body has not produced any reports suggesting that it monitored, evaluated, or corrected the system per se. In order to determine with specificity, each of the factors will be considered.

8.4.1 University and Industry Linkages

The Standard and Industrial Research Institute of Malaysia (SIRIM) (MP2 1971, 320) is a consolidation of the National Institute for Science and Industrial Research, and Standards Institution of Malaysia, established during MP1 (pp 132-136). It is the primary institution that oversees industry collaborations. It is a premier industrial research and technology organisation that is wholly owned by the Ministry of Finance Incorporated (MoFI) (a government-linked investment company (GLIC) under the Ministry of Finance) and under the purview of the Ministry of International Trade and Industry (MITI). It focuses on Industrial Centres (IC) innovation, particularly energy management, smart manufacturing, sensor, bio-medical, bio natural gas, and nanotechnology. Its technology centres are Industrial Biotechnology Research Center, Environmental Technology Research Center and Machinery Technology. Interestingly, there was no indication of electrical and electronics. However, there was information on building capability for the automotive industry through the Development of the Bumiputera Automotive Tool,

evelopment%20planning.&text=Meanwhile%2C%20the%20National%20Development%20Planning,to%20the%20Government%20(KSN).

Dies and Moulds (TDM) Industry project, which intended to enhance Bumiputera TDM industry clusters and increase their participation in the business[67].

The only evidence of potential University-Industry collaboration that can be seen at this stage is through SIRIM Tech Venture Sdn Bhd (STV), a subsidiary of SIRIM which is involved in the commercialisation of technology innovations generated from R&D. This organisation has entered a Memorandum of Understanding (MoU) with the University of Sains Malaysia for technology commercialisation. No details were available on the type of technology[68]. At present, SIRIM's focus is on biotechnology, which was identified as an area of focus in MP9. However, given that electrical and electronics are key industries, the lack of focus on them is problematic. Although the annual report provided by SIRIM as a corporate body reports its activities, there was no evaluation of achievements in quantifiable terms, i.e., numbers of collaborations and output. Additionally, there is no clarity of which governmental organisation reports on SIRIM’s progress, given it is under both MoFI and MITI. A quick check of the latest report by MITI in 2016 to find out whether there were progress updates on SIRIM revealed that the only reporting made was on SIRIM ensuring that automatisation of labour-intensive industries was delivered (a programme which was tabled in the 2015 Malaysian financial budget) (MITI 2016, 39). Given this form of ownership linkages, this hardly can be presented as a

[67] https://www.sirim.my/Pages/Media/annualreport.aspx
[68] https://www.sirim.my/Pages/Media/annualreport.aspx

University-Industry collaboration when it is a government-linked collaboration. What is worst is that the University is also a government-funded higher learning institution.

According to the MOSTI report card, about 135 researchers were placed in 35 companies under the Researcher-industry scientific exchange program. The placements of these researchers were reported to have achieved the Ministry's KPI.

Again, from the discussion, it can be gleaned that although various organisations are formed, no single organisation monitors or holistically links the policies. Unfortunately, the National Economic Planning unit functions as a secretariat instead of reviewing and monitoring these policies, programs and strategies to ensure it is aligned to achieve the overarching vision of the Malaysian policymakers.

8.4.2 Industry Needs and Skills Development

The call to improve quality, particularly in science and mathematics, has been ongoing, as evident in the various measures and organisations or agencies introduced. The University and University Colleges Act 1971 was amended in 1995 to allow public institutions to be corporatised to encourage private sector participation. This drive also resulted in the formation of the Higher Education Council to plan and coordinate the development of public and private institutions. The Department of Higher Education was strengthened to support the council.

Further private participation in education was encouraged, resulting in 47 private universities, 34 university colleges and 10 foreign university branch campuses being established. However, some corporatised government agencies also participated in education, i.e. Tenaga Nasional Berhad[69], Telekom Malaysia Berhad and Petroliam Nasional Berhad (PETRONAS). These changes were made to make education accessible and ease the burden of investing in education.

The Malaysian Qualifications Framework (MQF) and Malaysian Qualifications Agency was formed to control the quality of these higher learning institutions. This organisation, however, only had oversight over tertiary education; and there was no evidence to suggest that any such bodies were established for the lower levels of education – which are crucial for holistic innovation capability development. Following the argument in the preceding section, PADU was formed to evaluate, review and monitor the progress of the Malaysian Education Blueprint but has not discharged its duties. This finding reaffirms the claim that merely establishing a unit or department to monitor such progress without actually monitoring, evaluating and correcting does not yield the result required. There seems to be a dark structural maze that needs to be cleared and made simple, taking a cue from countries like Sweden, as discussed in Chapter 3.

[69] National Electricity Board

MP1 introduced vocational schools at the upper-secondary level. This push was furthered by MP2 when it conducted a study on the vocational system and resulted in the National Advisory Council on Industrial Training (NACIT) in 1972 to coordinate industrial training. At the same time, the National Industrial Training and Trade Certification Board (NITTCB) under the Ministry of Labour and Manpower was established to evaluate and certify skills. The National Industrial Training Council (NITC) was introduced to cover training in management, technician and craftsman skills. The push for vocational education at the upper secondary level was prevalent in MP3. The trades promoted *inter alia* were engineering trade, agriculture, commerce and home science, surveying, technical drawing and building construction. It was not evident that any automotive engineering or related skills were being promoted at this juncture.

By MP4, more vocational schools were erected, and one-year specialised courses were introduced, particularly in engineering related to electronics, which is congruent with Malaysia's electrical and electronic industry burgeoning during the concerned period. The push for skilled and semi-skilled workforce development was high on the agenda. By 1979, the Manpower Development Board (MDB) was formed to establish a link with the private sector, which NACIT subsequently took over. Further, the Industrial Training Institute (ITI) was created to support the electrical and electronics industry. However, these institutes were constantly in short supply of instructors and to facilitate the requirement, in 1984, the Centre for

Instructor and Advanced Skill Training (CIAST) was formed. The Look East Policy prompted on-the-job training to Japan and South Korea on industrial and technical fields during this period. However, the plans did not mention the fields, and therefore, it is assumed that these were related to heavy industries.

By 1989 (MP5), the National Vocational Training Council (NVTC) was formed to replace NITTCB, becoming the agency that planned and developed national vocational training according to industrial requirements. NVTC was also tasked to review trade skills standards in collaboration with the private sector. This introduced the National Occupation Skill Standards (NOSS), which recognised skills acquired through training and job experience. By MP7, Secondary Vocational Schools (SVS) were converted to Secondary Technical Stream (STS). At the same time, a new apprenticeship program was introduced. This conversion process was continued during MP8. The Japan – Malaysia Technical Institute was formed to promote mechatronics, industrial engineering technology, and computer engineering.

An attempt to streamline this convoluted development of vocational and technical training was made in MP10. It planned to make technical and vocational training mainstream and introduced the National Dual Training System (NDTS). It also introduced an apprenticeship scheme. The *National Skills Development Act* 2006 was passed to enforce accreditation processes. This resulted in the Department of Skills Development formation, which coordinated instructor training programs in public skills training institutions. It was to be the agency that developed and standardised TEVT from 2011. MP10 also introduced the Malaysian Skills Certificate as the national certification issued in 2012. To monitor technology-related courses, the Board of Technologists Malaysia was established.

A TEVT task force led by the Malaysian Qualification Agency (MQA) under the MOE and Department of Skills Development under the Ministry of Human Resources was formed in 2012 to coordinate, deliver and improve efficiency amongst the different institutions. It was also tasked to rationalise programs offered by public TEVT institutions. Industry-led bodies established under the Department of Skills Development of Ministry of Human Resources were required to prepare a National Occupational Skills Standard. In progressing the mainstreaming of the National Dual Training System, the National Human Capital Development Council was established.

In sum, the vocational and technical training development has not been streamlined; many institutions were formed and subsumed, causing challenges in developing this critical area of innovation capability development. There was no indication that the skills aligned to the planned industrial development – particularly the move into high-technology industries. The shift to the identified industries was premature based on the condition of vocationally and technically skilled workforce. This is evident because as far as the recent past two plans are concerned, i.e. MP10 and

MP11, the plans highlight a shortage of qualified trainers, which suggests that the capacity to develop a skilled workforce was impacted. Hence, the inability to make TEVT a choice may be affected by the lack of capacity due to limited trainers per se. Further, as discussed above, multiple organisations are reporting on specific progress, including MOSTI, MIDA, MITI and MOE, to name a few.

8.4.3 R&D

The importance of R&D was prevalent from the gleaning of the Malaysia Plans. In 1975, the National Council for Scientific Research and Development (NCSRD) was formed as a secretariat to the Ministry of Science, Technology and Environment and tasked to formulate R&D policies and provide a guide on R&D. At that time, the concentration was on agriculture. As a result, agricultural research institutes were formed for the various crops, including rubber and palm oil. However, the concentration on resource-based industry declined considerably (retained for other social-political reasons), the expertise garnered from these research institutes may not have been exploited extensively – perhaps there is a loss of comparative advantage in this regard.

Since Malaysia was a semiconductor assembling hub in 1985, the Malaysian Institute of Micro electrical Systems (MIMOS) was established to conduct basic and applied research in this area. The agenda to develop research in this industry was championed by MIMOS, which was seen throughout MP5 right up to MP11. This industry gained attention under the Intensification of Research in Priority Areas (IPRA), indicating public research institutes research priority. The type of sub-sectors within the industry that garnered attention were microelectronics, information technology and wafer fabrication. MP7 introduced the Malaysian Technology Development Corporation (MTDC) and the Malaysian Industry-Government Group for High Technology (MIGHT) to promote public and private collaboration in this industry. However, the plans did not report on the progress of these collaborations.

Notwithstanding, in MP8, MIMOS received funding to expand infrastructure to promote indigenous capacity development in the electronics industry. The Semiconductor Technology Program was tasked with developing skilled personnel with technology and product development expertise in wafer fabrication and integrated circuit design. Nonetheless, these measures were not assessed in subsequent plans, and the program's success is not ascertainable. Drawing from the discussion above on patents, it is evident that various organisations have not supported innovation capability development in this industry. Further, as discussed earlier, the TEVT and Education were not aligned towards improving capability. This conclusion is derived based on the information gleaned from the plans.

Further study on the industry-specific situation will better understand why these measures did or did not yield the results envisaged by the policymakers. Based on the limited data, the conclusion is that there is no synchronised approach to the promotion of industry, i.e. the industrial focus is not aligned with the promotion of vocational and technical studies. However, attempts are made to promote R&D. There is a systemic failure to some extent, which supports why Malaysia is unable to achieve its long-term goal of becoming a high-income country.

A summary of the present innovation structure is captured in **Figure 21.** Although the structure looks reasonably neat, it seems to lack a pivotal matter; no one organisation has been tasked to monitor, evaluate and correct the deliverables. These institutions seem to operate in silos and have multiple reporting channels. More sub-organisations seem to exist within these organisations, marring further the oversight regime.

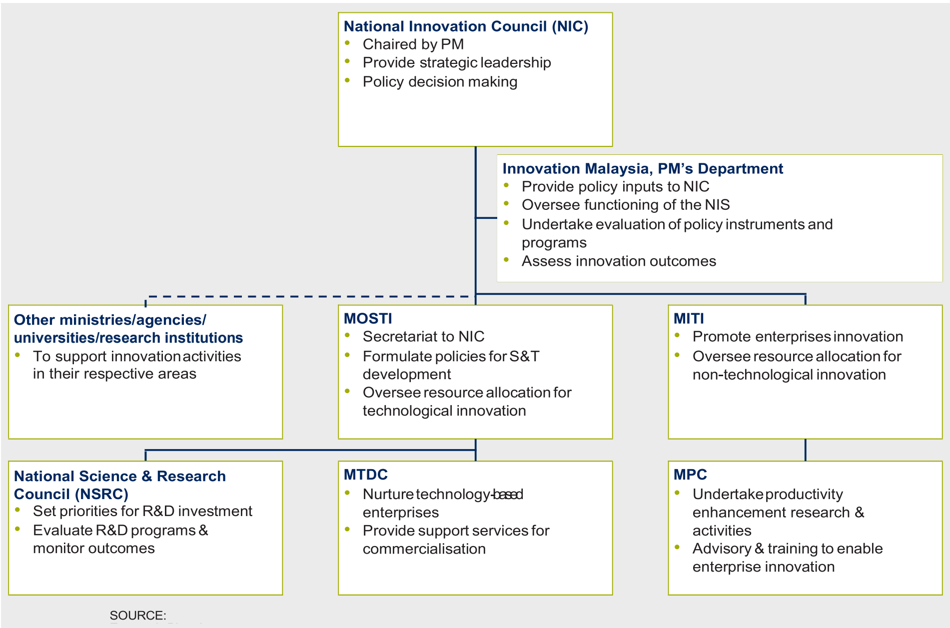


Figure 46 Innovation Institutions and Agencies

Source: MP11 (2016)

8.5 Conclusion

The analysis above demonstrates that when the Malaysian policymakers shifted into automotive, electrical, and electronics, the innovation system was unprepared for such a transition. There is ample evidence to support this claim, as discussed above and in Chapters 6 and 7. According to the proposition forwarded by scholars of innovation systems, a systemic failure seems to exist due to a misalignment of policy and the inability to monitor, evaluate and correct the system. The latter is more pertinent and needs to be addressed soon, should Malaysia want to achieve its target within the revised timeline. Besides, the lock-in identified is the NEP/NDP agenda, which detracts from economics into politics. It is clear that this policy has existed way past its due date and may result in serious consequences, particularly that of brain drain, if not re-evaluated.

On another note, the discussions also reveal that the immature transition was made without proper planning in having the required workforce. The lack of a qualified workforce has been continuing in perpetuity. This also concludes that shift into a new industry is doomed to fail if no competent and qualified workforce is available.

Another striking factor is the formation of various organisations, as identified above. These are duplicated and, after a run of time, have become too convoluted with no transparent reporting, monitoring and controlling mechanisms. The government primarily controls these organisations, and participation from the private sector has been minimal. The private sector involvement has been driven by government-linked companies or corporatised former government departments. This does not reflect the real private industry market. Again, this form of control is due to a heavily Chinese-controlled private sector, which may not align with policymakers' NEP/NDP agenda. Besides, the organisations created lacked the ability to bring to task non-performing organisations as compared to the Japanese or Korean model discussed above. Also, mechanisms to monitor strategies implemented were lacking, leading to wasted investment and inefficient capability development. The interactions between the actors of the innovation system are not established.

These discussions conclude that although Malaysia is developing reasonably, it will not break the glass ceiling if it does not invest effort in coordinated planning of the various actors in the innovation system. Importantly, it needs to ensure that these measures are monitored and re-deployed if required.

Further, when it comes to evaluating and reporting on the progress of agencies, in Malaysia, as highlighted above, it is not monitored by a single body such as the Implementation and Coordination Unit (ICU). Therefore a systematic performance evaluation system seems to be lacking. It will be nearly impossible to affix accountability and correct the system if it is not monitored and evaluated.

This practice is contrary to East Asian countries like Japan and Korea. In Korea, the Economic Planning Board (EPB) was even more potent than its Japanese counterpart, the Japanese Economic Planning Agency (JEPA). EPB was more directive, whereas JEPA was more collaborative and allowed private sector contribution to influence its decisions (Chang 2006, 114). The Korean Government was not hesitant to use a big stick in the form of disfavouring when it comes to credit rationing and foreign exchange, and carrots in the form of trade protection when making the firms perform (Chang 2006, 115). This degree of control is missing from the Malaysian strategy, maybe because there is a high presence of Multinational Corporations instead of local conglomerates. Perhaps that will be a possible avenue to start.

Chapter 9: Conclusions and Implications

9.1 Introduction

> *Focus should be as much on process and governance as it is on the outcomes. While we have achieved leaps and bounds in economic development since our Independence, past reforms also provide important lessons in areas where we must strive to do better. We have had roughly 60-70 blueprints and masterplans over the years; not all have been executed to their maximum potential. Let us identify the gaps and shortfalls and move forward from there. Although Malaysia's journey to transition to a high-income economy will be challenging, it is not out of reach. The key is to have the right mindset and values so that we attain, not just the high-income target, but also the qualities of a developed nation and society.* Datuk Nor Shamsiah Mohd Yunus, Governor, Central Bank of Malaysia (TheStar 2021).

This thesis resonates with the quote above. It has examined Malaysia's policies, programs, and strategies between 1965 and 2016 to assess the economic policies adopted, the institutions set, and output achieved. It aimed to study the development of the national innovation system longitudinally in developing innovation capability. In doing so, an analysis of how all these interacted, monitored and corrected was undertaken. This narrative established that Malaysia has undergone several structural changes that assisted it to achieve its current development status — higher middle income. However, since then, Malaysia has been stuck in *middle-income*, where it has lost its competitiveness, making countries at a lower level a natural choice for foreign investors (Griffith 2011, 39, Flaaen, Ghani, and Mishra 2013, 5, Cherif and Hasanov 2015b, 3).

In 1991, the then Prime Minister, dubbed the architect of modern Malaysia, Dr Mahathir Mohamad, revealed a vision for Malaysia: to attain a high-income status by 2020. This vision became the development mantra for all subsequent Malaysian policymakers. However, at the dawn of 2020, it was evident that the target was not achievable and extended to 2024.[70] To become a high-income country, Malaysia needs to achieve a gross national income (GNI) *per capita* of US$12,535 (Cheema 2020). This feat is achievable if the GNI per capita grows 4 to 4.5 per cent *per annum* (Kana 2019). However, given Malaysia's current state of innovation, whether this growth is achievable by the extended timeline is doubtful and raises serious questions about its innovation capability development.

In the next section, a recapitulation of the importance of innovation capability will be undertaken, followed by section 9.3, where the findings in Chapter 8 will be summarised. Further, the limitations and implications of the policies will be rationalised, and finally, the limitations of this thesis and recommendations for future research will be stated.

[70] MP12 indicates that this is extended to 2025.

9.2 The Importance of Innovation capability for the National Innovation System

Innovation capability is the engine of the National Innovation System; it reflects the potential of a country both politically and economically (Porter and Stern 2001, 5, Stern, Porter, and Furman 2000). Innovation capability is partly dependent on technological sophistication and the size of the scientific and technical workforce in an economy (Porter and Stern 2001, 5, Stern, Porter, and Furman 2000, Hu and Mathews 2005), and partly dependent on the interactions between the various actors in the system. Innovation capability enhances competitiveness, which is integral to economic progress. However, it is a difficult concept to measure. Using the conceptual framework, the deduction of the state of innovation capability in Malaysia was attempted in this thesis by triangulating the policies and strategies against the institutions established and outputs achieved. In doing so, the interactions of knowledge activities and skills development and R&D activities and innovation factors were considered. The manner these were analysed is as per the conceptual framework stated in Chapter 5. As many aspects are not capturable within one thesis, to provide a meaningful assessment of the innovation capability development in Malaysia, the automobile and electrical and electronics industries' development was evaluated in Chapter 8 to illustrate how innovation capability was developed in these sub-sectors. These two manufacturing sub-sectors were identified since they were promoted and pursued with vigour by Malaysian policymakers.

Korea is a vital comparator. It started with a GDP lower than Malaysia in the late 1960s and early 1970s, surpassing Malaysia as a leading global economy today. This extraordinary growth trajectory offers a valuable lesson for Malaysia and begs comparison. Both Korea and Malaysia emulated Japan, but with different results; hence, it is a natural choice as a comparator. However, this comparison is mindful of the societal and cultural background differences and is aspirational.

The literature identifies a strong correlation between strengthening labour skills and economic growth (Henderson and Phillips 2007, 79). Without a qualified and skilled workforce, a technology gap exists, preventing spillovers, which is the situation in Malaysia (Henderson and Phillips 2007, 91). This lack of skills prevents Malaysian firms from adopting and adapting to foreign technology. These arguments mirror the findings measured through the proxy of R&D commercialisation, as discussed in Chapter 8.

As evident from the discussions in the preceding chapters, the affirmative policies implemented since Independence to correct ethnic controlled economic activities have possibly hindered Malaysia's economic development. These policies have had a permanent presence in education, which is pivotal for innovation systems, and have prevented merit-based education. This approach was found in the latest MP11, where the education policy was geared to lift Bottom 40 (B40) households through preferred access to education and skills for students from this group (MP11 2016, 3-18, MP10 2011, 144). Hence, policies are concerned with societal corrective measures and not innovation capability development.

Although Malaysia drew inspiration from the East Asian countries and made considerable investments in education, it could not build an education system catered to structural transformations envisaged by the Malaysian Government (Fleming and Søborg 2014a, 121). The expansion of higher education should lead to linkages between education and innovation (Fleming and Søborg 2014a), which is not the situation with Malaysia. MP10 revealed that Malaysia had a long way to go in catching up with first world skill and talent base (Fleming and Søborg 2014a, 122, MP10 2011, 192). Despite the significant number of graduates produced, it seems that the supply portfolio was incompatible with the demand portfolio (Fleming and Søborg 2014a, 121). Further, many graduates having low competence in English reduces competitiveness (Fleming and Søborg 2014a, MP10 2011, 201). The difficulty in meeting the demand for higher-skilled labour delays the chances of becoming a high-income nation as planned (Fleming and Søborg 2014a). MP10 and the Talent Road Map 2020 aimed to strengthen graduate performance through de-centralisation amid concerns of erosion of the Malay elites' existent privileges and the Malay population's preferences (Fleming and Søborg 2014a, MP11 2016, 5-1). This outcome leads to a paradoxical dilemma of having graduates with higher education yet unable to satisfy the market's demands (Fleming and Søborg 2014a).

It is pivotal that Malaysia produces graduates with the requisite skills to satisfy the demand for skilled workers — especially in services and manufacturing (Flaaen, Ghani, and Mishra 2013). Despite acknowledging the acute shortage of qualified and skilled workers, there seems to be a lack of effort to establish meso-organisations such as universities and R&D laboratories. Again, the Economic Transformation Program (ETP) is an effort on the part of the government that disregards the linkages and actual economic structure of the country (Rasiah 2014, 85). The policy recommendation is that qualified people take charge of the institutions that develop and accelerate economic growth.

By contrast, in Korea, education and training policies have been interlinked with the country's development goals, and decisions on the provision of education and training are concerned solely with economic development (Cheon 2014, 221). This concentration meant education and training expanded sequentially with the intent to transform the knowledge base of the labour force in anticipation of the intended diversification patterns, responding to the demands and skills of the industries to be established (Cheon 2014, 221). The Korean policymakers meticulously planned each industrialisation phase, which was starkly different from the Malaysian situation, as evidenced by the narrative undertaken in Chapters 6, 7 and 8. Korea, in the 1970s, emphasised heavy engineering and chemical industries when it promoted technical and vocational courses – which was the feeder for its intended industrial transition (Cheon 2014, 221).

9.3 Findings

This thesis set out to answer the following research questions:

1. What innovation policies and strategies were developed between 1965 and 2016 to build innovation capability?
2. Who were the actors established according to these policies and strategies?
3. Were there interactions between these actors in achieving the targets of the policies and strategies?
4. How were these actors and interactions (if any) monitored and corrected from 1975 and 2016 to achieve the policy targets?
5. Can a correlation be drawn between these policies and strategies and innovation output during this period?

In answer to the first research question, this thesis finds that the approach taken by the policymakers towards economic development was influenced by a past that outlived its time — costing Malaysia its economic progress. The analysis reveals that the policymakers were focused on using NEP (affirmative policy) from MP2 persisting to MP11. This approach of mixing its policymaking agendas of re-engineering the socio-economic structure whilst promoting economic development has prevented Malaysia's progression into becoming a high-income country. This policy failure has been admitted by the person who had pursued it vehemently himself. Mahathir Mohamad said that it has led to a *crutch mentality* and admits that Bumiputera entrepreneurship would have reached the world level through competition (Gomez 2009, 364). The residual harm this approach has caused is that it has not provided the support that could have been given to the non-Bumiputera entrepreneurs who would have been able to develop technology capability and bridge the gap at the innovation frontier similar to the other East Asian countries (Gomez 2009, 364). This policy, unfortunately, has become a permanent consideration in economic factors such as education, R&D and managing institutions in support of the same. In sum, the approach taken was path-dependent and steeped too much into non-economic considerations of integration of the racial component and improving work ethics, which by contrast to the East Asian countries, is starkly different given it treated those factors purely as an economic venture.

Further, premature structural changes were made before ensuring sufficient resources to operationalise such transitions, as seen from the car manufacturing project. The innovation capability development was not aligned to the industries promoted by the policymakers — resulting in a mismatch between the supply and demand of the workforce. Additionally, the organisations and regulatory frameworks introduced seem to be too interventionist, with minimal participation from the private sector. Although the plans regularly mentioned the importance of the private–public partnership and ventured into privatisation activities of the government-held organisation, in the beginning, these ended up with the creation of a multitude of government-linked companies tasked to drive the economy. Again, as elucidated from the plans, these ventures have not significantly contributed to building innovation capability, as discussed in Chapter 8.

In answer to the second question, a multitude of institutions were established. The numbers of institutions set up to develop innovation capability were manifold to the extent that it began to mar and complicate the reporting structure and functions and powers. Some institutions or actors were duplicating functions, and many, mostly bureaucratic, occupy the innovation system.

The answer to the third question is linked to the second. Due to an excessive number of actors within the innovation system, the clarity on reporting structure and the interactions between the parties cannot be easily established. For instance, skills development was the purview of the Ministry of Education. However, various training bodies also take up some aspects of skills training, including MIMOS, with no clarity on how these actors interacted to eliminate duplication and wasted resources.

In answering the fourth question, the historical data could not provide concrete evidence of one body reporting on the progress of the multitude of bodies. The monitoring and correction of the system seem to be evidently missing. As alluded to earlier, the EPB monitors and proposes correction to the system when required in the Korean system. This finding is crucial, as Malaysian policymakers must establish or consolidate the existing bodies to undertake such an exercise. In order to illustrate this point, referring to SIRIM as discussed in Chapter 8, the monitoring and evaluating of this government agency seems to be virtually non-existent, given that no Ministry seems to report on its activities. This example supports the claim that there is no proper mechanism to undertake these activities within the Malaysian National Innovation System. Hence, the policymakers need to stocktake all the actors within the innovation system and simplify the structure through consolidation. Further, the innovation system structure should be lean to maintain transparency, besides making it easier to monitor and correct the system.

In answer to the final research question, the finding suggests that towards MP10 and MP11, there was evidence of attempts to align the R&D and innovation policies and strategies with the output. This outcome was particularly visible for the electrical and electronics sub-sector. However, it was not evident with the automotive sub-sector. While the outputs are reasonable in relation to R&D, it has a long way to achieve its target. The educational outputs suggest no correlation between educational policies and the output, given the continuous acute shortage of qualified technical workforce.

In sum, the skewed educational outputs; the multiplicity of agencies, firms, and organisations without proper monitoring; poor planning when entering into industries; a lack of private sector participation in economic development activities and a high reliance on state-owned enterprises hampers the development of innovation capability.

Despite the activities rolled out, the weaknesses in the innovation system were that it lacked coordination in the implementation of science and technology and education policies, it had inadequate linkages between industry and society to universities and Government Research Institutes as well as the insufficient transfer of technology and technical spillover from foreign to domestic firms. It will bridge the gap quicker if it is aligned, implemented consistently, monitored, and the system corrected in a timely fashion.

9.4 Policy limitations and Implications

Malaysia's historical legacy has become the bane to development, as affirmative policy measures have failed to develop the best a policy lock-in. By contrast, the East Asian economies have been singularly focused on achieving global competitiveness. As discussed, these inter-ethnic redistribution factors were prevalent and could be witnessed in policies implemented from 1980 to 2000. As an illustration, the Industrial Coordination Act (ICA) 1975 introduced a 30 per cent

Bumiputera holding requirement regardless of ethnic Malay contributions in the industry — not a policy that develops competitiveness.

On the same note, the "Look East" policy suffered inherent weaknesses from its initiation. The weaknesses were that (1) it lacked a blueprint for its implementation, being fuelled mainly by the anti-west sentiment held by Mahathir; and (2) it failed to take stock of the social and cultural differences between Malaysia and Japan (Furuoka 2007, 509). It was nearly unimaginable to replicate the work ethics of a society completely different from the Malaysian set-up. A cynical view would be that the only result of sending hordes of students to Japan to imbibe their ethics and values has been the spread of *karaoke* (Furuoka 2007, 510). Although it is tongue in cheek, the truth of it is biting.

The implication of these policy choices needs no further elaboration as it is evident given that Malaysia has been in the *middle-income trap* for the last 28 years and still counting.

9.5 Limitations and recommendations for future research

This thesis employed a qualitative method of analysing secondary data, that is the medium-term plans, associated policy documents, statistics from Malaysian government agencies and other international organisations, and scholarly works.

These materials were freely available and accessible to the researcher. The researcher acknowledges that materials may be overlooked, which may be pivotal due to their accessibility. Inherently, this has limited access to other primary data, which may add richness to the narrative contained in this thesis. Although, as acknowledged by literature, measuring innovation capability is difficult, this thesis has corroborated the findings of studies by International Organisations such as the World Bank recently through its assessment of the effectiveness of Public Research Institutions (Worldbank 2020). The dissection of the medium-term plans provides a rich historical narrative to support the claim that the Malaysian innovation system needs to be re-evaluated and re-calibrated to meet the development plans of the policymakers. Consequently, future research in this area may focus on collating primary data and triangulating the data contained in this thesis to provide a holistic narrative.

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