AN EMPIRICAL INVESTIGATION OF NATIONAL INNOVATION SYSTEM OF AN EMERGING ECONOMY: A STUDY OF MALAYSIA

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ABSTRACT

This thesis examines the National Innovation System (NIS) of emerging economies using Malaysia as a case by exploring its constituents, including firms and organisations, and the national context in which they function. The NIS has been studied and applied mostly in developed economies, but only since the 1990s, there has been a focus on the emerging economies. Also, scholarly discussions on the NIS has remained overly conceptual and descriptive. Consequently, it has produced little operational or practical value. These challenges have restricted the capacity of governments to devise suitable policies to shape innovation outcomes for economic development. In light of these shortcomings, this thesis seeks to test the following hypotheses, (1) there exists an underlying hierarchical factor structure (latent constructs) of firms and national context related dimensions in firms' innovation activities within NIS; (2) the dimensions of NIS by firm attributes and their contexts have a significant impact on innovation outcomes as enablers or as problems; and (3) the impact of NIS contextual factors on innovation outcomes is mediated by firm attributes. The study draws on a national sample and deploys a quantitative methodology to analyse the data. The Malaysian National Innovation Survey 2012 data from the Ministry of Science, Technology and Innovation is a source of the data used this thesis. The thesis uses statistical techniques associated with hybrid factor analytic models and structural equation modelling. The findings show that the NIS is a multi-dimensional and multi-level system, which comprises of sound and valid patterns or dimensions of firms and national contexts in which firms function. The structural models confirm higher explanatory power and predictive relevance in the manufacturing sector than in services. The evidence also shows that information asymmetries and ability to articulate demand emerge as systemic problems in the research. Finally, the thesis establishes that national contexts that influence innovation outcomes through firm attributes. These findings generate significant theoretical and policy implications for innovation policy. Future research can consider additional dimensions, such as social, political and historical owing to path dependency, policy owners' perspectives and further extensions to the meaning of NIS and the conduct of actors in the system.

Keywords: national innovation system, quantitative modelling, innovation outcomes, emerging economies

SIASATAN EMPIRIK SISTEM INOVASI NASIONAL NEGARA EKONOMI MEMUNCUL BERPANDUKAN KES MALAYSIA

ABSTRAK

Tesis ini mendekati Sistem Inovasi Nasional (NIS) ekonomi memuncul berasaskan kes Malaysia dengan menganalisis komponen, termasuk firma dan organisasi, dan konteks nasional dalam mana mereka berfungsi. NIS dikaji dan digunakan tertutamanya di Negara maju, namun sejak 1990an muncul tumpuan keatas ekonomi memuncul. Juga, perbinacangan ilmiah terhadap NIS masih terlalu konseptual dan deskriptif. Lantaran itu, ia kurang menghasilkan nilai yang dapat diguna atau praktik. Cabaran ini telah menyekat keupayaan kerajaan untuk mengaturkan dasar demi mendukung pembangunan ekonomi. Disebabkan kekurangan ini, tesis ini meninjau tiga hipotesis berikut: (1) wujudnya struktur factor berbentuk hirarki (bentukan terpendam))firma dan konteks nasional dimensi berkaitan dalam kegiatan inovasi firma didalam NIS; (2) dimensi NIS berasaskan ciri-ciri firma dan konteks mereka memberi kesan signifikan keatas hasil inovasi sebagai pemungkin dan sebagai masalah; dan (3) kesan faktor konteks NIS keatas innovasi diantara oleh ciri-ciri firma. Tinjauan ini berlandaskan sampel data nasional dan mengunakan perkaedahan kuantitatif. Data Tinjauan Inovasi Nasional Malaysia 2012 daripada Kementerian Sains, Teknologi dan Inovasi menjadi punca data tesis ini. Tesis ini mengunakan teknik perangkaan berkait dengan model hybrid faktor dan permodelan persamaan struktur. Dapatan menunjukan bahawa NIS merupakan satu system pelbagai-dimensi dan pelbagai-peringakat, yang mengandungi dimensi bernas ataupun dimensi firmsa dan konteks nasional dalam mana firma berfungsi. Model struktur mengesahkan kuasa penjelasan tinggi dan kesesuaian ramalan NIS dalam sector perkilangan dan perkhidmatan. Penemuan juga menunjukan bahawa maklumat tidak simetri dan kebolehan untuk menjanakan perminataan muncul sebagai masalah sistemik dalam penyelidikan. Akahirkata, tesis

ini menagakkan bahawa konteks nasional mempengaruhi hasil inovasi melalui ciri-ciri firma. Penemun ini menjanakan implikasi teori untuk dasar inovasi. Penyelidikan akan dating boleh mempertimbangkan dimensi tambahan, seperti sosial, politik dan sejarah kerana jalan turutan, pendekatan pemilik dasar, serta perluasan pengertian NIS dan gelagat pelaku dalam sistem itu.

Keywords: system inovasi nasional, permodelan kuantitatif, hasil inovasi, ekonomi memuncul

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

CHAPTER 1: INTRODUCTION

This study examines the concept of National Innovation System (NIS) in emerging economies by exploring the constituents of it from firms' perspective in term of their attributes and national contexts. The purpose is to offer governments pathways to catch-up through the collective efforts of governments and firms. This chapter presents the background of the research, statement of problem and scope, research context, research questions and hypotheses, the structure of the thesis and definition of fundamental concepts.

1.1. Background of the Research

Innovation is the spearhead of economic development. Governments expect businesses to leverage on innovation for their benefit and eventually for national benefit. Various stakeholders are encouraged to play a responsible role in delivering innovation outcomes. This propagation goes back to Schumpeter (1942) who proclaimed innovation as the primary driver of change in the capitalist economy and Romer (1990) who viewed innovation as the main driving force of economic growth. Modern capitalistic economies depend on innovation for growth (Rodríguez-Pose & Crescenzi, 2008). A country's capacity to acquire, absorb, disseminate, and apply modern technologies is the capability of its National Innovation System (NIS) (Watkins, Papaioannou, Mugwagwa, & Kale, 2015) and it has a closer link to successful economic development (Metcalfe & Ramlogan, 2008). Historical and descriptive evidence also suggests that countries that have succeeded in catch-up have given a high priority to NIS for development (Fagerberg & Srholec, 2008; Kim, 1997; Nelson, 1993; Wade, 1990). The empirical analysis of Fagerberg and Srholec (2008) suggested that a well-developed innovation system is essential for countries that wish to succeed in catch-up. The findings of their study of 115 countries around the world showed a strong, significant and robust statistical relationship between (level and change of) Gross Domestic Product (GDP) per capita on the one hand, and (level and change of) the innovation system on the other. This view leaves nations with no question of whether to innovate or not but rather how to innovate (Klochikhin, 2012). NIS concept provides the framework within which governments and firms negotiate policies to influence innovation outcomes in a national scenario. NIS approach is a useful and promising analytical tool for scholarly pursuit in innovation and development of innovation policy (Edquist, 1997; Furman, Porter & Stern, 2002; Lundvall, 2007; Metcalfe, 1997) since this approach fosters an understanding of innovation process and determinants (Guan & Chen, 2012).

There are many discussions on the origin of the concept of NIS. This study views Schumpeter's technological innovation theory in the early 1930s to 1940s as the origin of NIS as indicated by Niosi, Saviotti, Bellon, and Crow (1993). Based on these authors and other sources from Smith (2000), the concept was then built on with the nature of the environment such as demand and market (Schmookler, 1966) and capabilities within the firms such as Research and Development (R&D) (Freeman, 1972). It further developed into inter-firm interaction, technical alliances and collaborations and agreements (Fusfeld & Haklisch, 1985; Mariti & Smiley, 1983; von Hippel, 1976). It advanced into user-producer interaction (Teubal, 1977), systemic nature and technical systems (Gille, 1978), science and technology (Mowery & Rosenberg, 1979) and Government as an enabler through policies (Nelson, 1982; Rothwell & Zegveld, 1981) to become National Innovation System (NIS) in 1987. Freeman in 1987 used the term NIS for the first time in published form. He represented it as the 'National System of

Innovation', and he defined it as 'the network of institutions in public and private sectors whose activities and interactions initiate, import, and diffuse new technologies' (Freeman, 1987, p. 1). The literature review chapter discusses different phases of evolution of the concept. Freeman (1987), Lundvall (1992), Nelson (1993), Nelson and Rosenberg (1993) and Edquist (1997) are the advocates who contributed in developing the concept of NIS. The NIS approach branched into different directions in the 1990s. The two broad directions discussed are regional (Asheim, Smith, & Oughton, 2011; Autio, 1998; Braczyk, Cooke & Heidenreich, 1997; Cooke, 2001) and sectoral (Breschi & Malerba, 1997; Malerba, 2002, 2004) focused. They are Regional Innovation System (RIS) and Sectoral Innovation System (SIS) respectively. However, according to Samara, Georgiadis, and Bakouros (2012), the NIS approach is most frequently used to understand the elements and complex inter-relations that constitute the innovation process in the last two decades. Since mid-nineties, this approach has been recommended by the OECD too (Godin, 2009). Two great organisations popularised the concept by advocating and applying the concept in the 1960s for policy purposes and are the Organisation for Economic Co-operation and Development (OECD) (Godin, 2009) and the RAND Corporation (Hughes & Hughes, 2000). The RAND Corporation is a research organisation developing solutions to public policy challenges to help communities throughout the world safer, more secure, healthier and more prosperous.

NIS concept is not exceptional without any criticism (Dodgson, Hughes, Foster, & Metcalfe, 2011) regarding its academic status, the extent of its explanatory powers (Sharif, 2006), the methods used to assess how innovation systems work and their performance (Edquist, 2005). A critical assessment of the NIS referred it as a ''Transdiscursive'' (overarching concern to multiple discourses) concept that crosses the world of academia with the world of policymakers (Sharif, 2006). However, this nature of the concept is especially intriguing and illuminating (Miettinen, 2002; Sharif, 2006). Though there were other competing views to NIS such as Knowledge-Based Economy, Porter's Industrial Clusters and Triple Helix Concept, Miettinen (2002) and Lundvall, (2007), argue that the looseness and openness of the NIS concept have contributed to it thriving both in academic and public policy circles compared to other approaches. In reality, NIS concept's accelerated spread is due to its fuzzy boundaries distinguishing academic and policy circles that allowed for cross-fertilisation by theoretical and policy considerations (Smith, 2000). Sharif (2006) argued that 'transdiscursive' character not necessarily make the concept ''unscientific''. The example given by the author included social theory being 'transdiscursive' to become ''formal theory''. Therefore, this study aims to contribute regarding the explanatory power of the NIS in assessing the performance of national innovation outcomes.

A report by OECD (1999) indicated that Innovation processes have many common characteristics and several common trends influence them. However, countries differ in their translation of these factors into innovation and, ultimately, into new products and services. Within nations, organisations or firms are considered the essential agents (Edquist, 2005; Nelson & Rosenberg, 1993) in translating the characteristics or traits into innovation (Meuer, Rupietta, & Backes-gellner, 2015). Therefore, national contexts and firm attributes play a crucial role in realising innovation outcomes.

Lately, more and more emerging economies are resorting to NIS for economic growth, development and catching-up purposes. Notions of technological 'catch-up' and economic growth have always been central to the NIS concept (Lundvall, 2007). However, Metcalfe and Ramlogan (2008) highlighted that the idea was conceived on institutional structures and activities in developed countries such as Japan, United States of America (USA), Germany, Sweden and so on as per early literature on this concept. Sharif (2006) pinpointed the first use of NIS concept for providing a concept for making country-level policy for Finland. In a review in 1993, the NIS concept was heralded as part of the country's developmental and recovery strategy while the country was in recession. Policies in response to the NIS concept helped to haul Finland out of recession. The newly industrialised countries (such as South Korea, Taiwan, and Singapore) and countries of Latin America (such as Mexico and Argentina) followed and applied the concept. Recently, this concept has been applied to developing countries such as emerging powers of Brazil, India, China, and South Africa; South East Asian countries Malaysia, Thailand and Philippines; and more limitedly to less developed countries. Although developed economies have widely exploited and studied the NIS concept, only lately there is considerable scholarly interest in emerging or developing economies. However, emerging economies differ significantly from developed economies regarding national contexts and firm attributes in realising innovation outcomes. A better understanding of this issue should help emerging economies regarding devising informed policies and strategising firms' efforts towards achieving intended national innovation outcomes for economic benefit. Therefore, this study aims to take advantage of the informational structures of the national environment and firms of an emerging economy to explain the embedded NIS and resultant innovation outcomes. The next section elaborates the statement of the problem.

1.2. Statement of Problem

The literature on the NIS concept attracted not only economists but also many 'innovation researchers and policymakers' (Edquist & Hommen, 2008). However, Niosi (2002) claimed that the progress in refining the NIS concept has been uneven and difficult to assess; and for Edquist (2005), there is a need for theoretically based empirical research to 'straighten up' NIS approach and make it more 'theory-like'. Furthermore, the NIS approach has been criticised by scholars for not providing sufficient practical guidelines for policymakers (Edquist, 2004; Godin, 2009; OECD, 2002; Sharif, 2006; Woolthuis, Lankhuizen & Gilsing, 2005), especially for emerging economies. Much of the work in NIS approach for policy has been conceptual and descriptive (Chaminade, Intarakumnerd, & Sapprasert, 2012; Samara et al., 2012; Sharif, 2006). Based on Godin (2009) and OECD (2002), the concept also has little operational or practical value, which makes it difficult to implement (OECD, 2012). Sharif (2006) pointed out that these criticisms are because the concept lacks concrete and consistent operationalisation, and framework to formulate conjectures or hypotheses to test them empirically. Uyarra (2010) also highlighted that innovation systems and related concepts lack clarity, which renders the operationalisation and even the empirical validation of the concepts problematic. After examining different issues from the East Asian innovation and learning experiences, Rasiah (2011b) indicated that the heterogeneity of the examples demonstrate that the evolutionary theory and methodology of using empirical evidence is critical to capture the specificity of the issues. A bibliometric analysis (1963–2012) done by Sun and Grimes (2016) indicated that the most important seminal works during this period were theoretical rather than empirical. Simply grasping the conceptual structure of innovation systems does not allow one to control the operational quality of innovation systems through specific empirical management, which depends on measuring innovation performance and exploring its determinants (Guan & Chen, 2012). Samara et al. (2012) and Chaminade, Intarakumnerd, and Sapprasert (2012) added that the outcome of the empirical attempts has often been a description of NIS's formal organisations' Science, Technology and Innovation (STI) outcomes. Otherwise, the empirical studies are related to internationalisation of innovation systems (Sun & Grimes, 2016) mainly using national aggregate indicators for descriptive comparisons. All these discussions highlighted that there is lack of empirical attempts in theorising the concept. However, this is very important for analytical and policy purposes.

Also, studies and policy initiatives using the concept did not attempt to differentiate the NIS of emerging economies from developed economies (Edquist, 1997; Lundvall, 2005). Emerging economies differ significantly from developed economies regarding their national environment or context (Bellows, 1995; Edquist, 1997; Klochikhin, 2012; Lundvall, 1992; Lundvall, 2005; Nelson, 1993; Niosi, 2011; Rauch & Evans, 2000) and firm attributes resulting in innovation outcomes (Lundvall, 2007; Nelson & Winter, 1982; Nelson, 1991; Srholec & Verspagen, 2008). Justification section in this chapter discusses the differences. However, empirical studies considering these differences for a comprehensive and whole systems analysis for policy design are scarce in the literature.

This study further argues that the differences in NIS concept between developed and emerging economies need to be understood from the core of the NIS that are firms (Lundvall, 2005) within the national context where innovation is realised and applied, which eventually creates economic outcome (Lundvall, 2007). However, there is a gap in the understanding of firms regarding innovation outcomes of the nation (Lundvall, 2007; Watkins et al., 2015; Whitley, 2007). Furthermore, in most of the emerging economies, both manufacturing and services sectors play an equally important role in contributing to the economy. The firms from these sectors significantly differ in their attributes and response to the national stimuli or contexts. However, in practice, the demarcation between the different economic sectors are not clear. The delineation is especially correct between the manufacturing and services sectors (Berg, Tien & Wallace, 2001; Mangiarotti & Riillo, 2014; Tien & Berg, 1995), which differ in their response to national contexts that result in innovation outcomes (Mangiarotti & Riillo, 2014; Tien, 2007). These differences add to the argument that sectoral variations contributing to innovation outcomes are essential in the understanding of NIS from the firms' perspective in emerging economies. However, there is lack of empirical evidence to contribute to this understanding. Therefore, the following question arises: Is the general understanding of National Innovation System suitable for emerging economies to shape the national policy agenda for innovation outcomes?

The question related to the understanding of NIS concept requires investigation due to the escalating interest in NIS concept from scholars and governments for catching-up for emerging economies. In summary, there is a gap in the understanding of NIS in emerging economies from firms' perspectives considering sectoral differences. Therefore, there is a need for a practically useful analytical framework that allows for the assessment of system performance as well as the identification of factors or constituents influencing innovation performance in emerging economies for policy purposes. This study takes the empirical path in an attempt to theorise the concept. The following topic justifies this research from theoretical and policy perspectives.

1.3. Justification of the Research

This section of the chapter justifies the study from theoretical and policy perspectives for both NIS for emerging economies and NIS literature as a whole. From the theoretical perspective, this study responds to the identified opportunity to explore the concept of NIS for catching-up in emerging economies as a promising research setting. There is much attention given to the NIS concept, yet empirical investigations of NIS approach considering three main aspects (dimensions of NIS, their interrelationships, and systemic problems and enablers) that shape the innovation outcomes for the nations are missing in the extant literature discussed in chapter 2. Considering the constituents of innovation system from the viewpoint of system promotion as advocated by Lundvall (2007) and Edquist and Hommen (2008), the following gaps are identified. The first gap in understanding is about national contextual aspects (Carlsson, Jacobsson, Holmén, & Rickne, 2002; Edler & Fagerberg, 2017; Edquist & Hommen, 2008), and the second one regarding firm attributes (Lundvall, 2007; Weber & Rohracher, 2012; Schøtt & Jensen, 2016). The third aspect that lacks understanding is the heterogeneity of the sectors (Breschi & Malerba, 1997; Lee & Malerba, 2017; Lundvall, 2007) within the national context. From the policy perspective of governments, firms and sectors, this study responds to the following concerns raised on the concept. The first concern is about not providing practical enough guidelines for policymakers (Edquist, 2004; Woolthuis et al., 2005) as most of the policy works are conceptual and descriptive (Chaminade et al., 2012; Samara et al., 2012) especially for emerging economies. The second one is about not attempting to differentiate the NIS of emerging economies from developed economies (Edquist, 1997; Lundvall, 2005). The following topics discuss in detail the theoretical and policy considerations.

1.3.1. Theoretical Considerations

Despite the growth in the scholarly interest for NIS concept, the overall body of research distinguishing it between developed and emerging economies, remains limited (Edquist, 1997; Lundvall, 2005; Surie, 2017; Wonglimpiyarat, 2014). Scholarly discussions in this field pointed out at least three gaps in the conception of the NIS concept itself in explaining emerging economies as discussed below. Bridging the gaps in the understanding is critical for the NIS literature for catching up purposes.

The first gap relates to the understanding of NIS regarding its national contextual constituents. Though scholars from different academic disciplines have made contributions in developing the NIS concept through various approaches, only a few studies focus on the NIS in developing countries (e.g. Intarakumnerd, Chairatana, & Tangchitpiboon, 2002; Rasiah & Govindaraju, 2009; Surie, 2017; Wonglimpiyarat, 2014). The NIS approach has been conceived mainly in developed economies. The concept is used to describe and compare relatively strong and diversified systems with well-developed institutional and infrastructure support of innovation activities (Edquist, 1997; Lundvall, 1992; Lundvall, 2005; Nelson, 1993), and characterised with efficient and transparent public sector bureaucracy (Niosi, 2011). Studies on emerging economies also show that their bureaucracy is weak due to politics and frequently changing bureaucracy based on patronage of efficiency (Bellows, 1995; Rauch &Evans, 2000). Furthermore, the NIS has been criticised by the historical, cultural, economic and political context of the developed world, which differ significantly from the ones observed in the non-OECD economies (mostly emerging economies) (Klochikhin, 2012).

The Oslo manual on 'Guidelines for Collecting and Interpreting Innovation Data' (OECD & Eurostat, 2005) outlined the indicators and measures of innovation. OECD and Eurostat (2005) also indicated that the size and structure of markets and firms in developing countries have the presence of a large percentage of small and medium enterprises (SMEs) and large enterprises. These firms are operating at suboptimal production scales with higher unit costs far from optimal efficiency and compete based on the exploitation of natural resources or cheap labour rather than on efficiency or differentiated products. The innovation landscape in emerging economies is characterised by 'macroeconomic uncertainty, instability, physical infrastructure (lack of basic services such as electricity or communications technologies), institutional fragility, lack of social awareness about innovation, risk-averse nature of operations, lack of entrepreneurs, high barriers to entry, and lack of public policy instruments to support business support and management training' (OECD & Eurostat, 2005, p.136).

The characteristics and state of innovation raised by OECD and Eurostat (2005) imply that the developing or emerging economies differ significantly from developed economies. Even the early studies related to NIS in emerging economies, such as Kim (1993) on Korea focused on capacity building and national innovation, Hou and Gee (1993) on Taiwan supported technical advance, and Wong (1996) on Singapore focused on aggressive policies to intensify technological learning. Each national context is different as they vary with the economic structure, timing of learning and catch-up and location spatially (Nelson, 2008). Lundvall (2005) indicated that the approach should be different for emerging economies. The focus needs to shift in the direction of system construction and system promotion, which is in line with Friedrich List who pointed out as a German catching-up strategy in the 19th Century. List (1841) focused on the development of productive forces rather than on allocation issues. He urged the Government to build national infrastructure and institutions to promote the accumulation of 'mental capital' and use it to spur economic development. According to Lundvall (2005) the first written contribution using the concept of 'national system of innovation' by Freeman (1982) on 'Technological Infrastructure and International Competitiveness', was written very much in the spirit of Friedrich List, pointing out the importance of an active role for government in promoting technological infrastructure. It is thus apparent that the innovation system approach proposed for emerging economies should take account of national contexts (environment regarding institutions, infrastructure, market and so on) for innovation. Studies of this sort provide an understanding of the importance of national contextual constituents of NIS of emerging economies.

The second gap in knowledge relates to the microstructural explanations of NIS. NIS is a macro concept (Samara et al., 2012) and existing studies provide macro institutional explanations of NIS (Watkins et al., 2015). However, Lundvall (2007) pointed out that, for emerging economies, there is a need to shift the focus away from macro institutional explanations to microstructures, such as firms. Because firms are the units that play the most crucial role in the innovation system (Lundvall, 2005) and are the critical, innovative agents in market economies (Whitley, 2007). The well-known 'innovation systems' (IS) approach, is based on the argument that what appears as innovation at the macro level is the result of an interactive process that involves actors at the micro level (Scandura, 2015). At the micro-level, at the core of the NIS, there exist firms (Lundvall, 2005). There is a need to understand how the core of the innovation system is embedded in the wider set of institutions (Lundvall, 2007) and other national contexts in emerging economies shaping the national economy (innovation outcomes). Researchers have pointed out that national innovation systems display unique characters (Lundvall, 1992; Nelson & Rosenberg, 1993), which reflect the resources and institutions in a given country that domestic firms can leverage to support their innovative efforts for the benefit of their own and the country (Spencer, 2003). Firms are heterogeneous regarding their attributes and behaviour. The key element of evolutionary economics is that firms in the "real world" show considerable heterogeneity in their routines and strategies that they apply (Srholec & Verspagen, 2008). They also differ in their capability or skills of their workers, experience, firm size and organisational form (Nelson & Winter, 1982; Nelson, 1991). Economic and organisational analysis of innovation elaborates the conjecture of heterogeneity in innovative behaviour (Christensen, 2002; Massini, Lewin & Greve, 2005). Lundvall (2007) pointed out that firms from emerging economies are less engaged in innovation and learning. The author also added that there is a lack of data on what goes on inside firms in these countries. Even the scarce data available may not be reliable. Several authors (Edler & Fagerberg, 2017; Lundvall, 2005; Patana, Pihlajamaa, Polvinen, Carleton, & Kanto, 2013; Schøtt & Jensen, 2016; Weber & Rohracher, 2012; Whitley, 2007) highlighted that innovation and economic benefit are based on firms' activities and their environment in innovation system research. Therefore, it is critical to get a better understanding of firms in connection with innovation (Lundvall, 2007). The author also added that without knowing about the microstructures, scholars and policymakers might get little out of attempts to manipulate institutions and organisations at the meso- and macro-level. In this aspect, an understanding of firms within the national environment or context in emerging economies would inform the NIS framework and theories associated with that.

The third gap is related to sectoral differences, which is one of the most influential views in the economics of innovation (Dosi, Marsili, Orsenigo & Salvatore, 1995;

Malerba & Orsenigo, 1997; Malerba, 2002; Pavitt, 1984). Arundel, Lorenz, Lundvall, and Valeyre (2007) suggested dividing the economy into the two main sectors of services and manufacturing. The manufacturing sector provides critical products (e.g., autos, computers, aircrafts, telecommunications equipment) that enable the delivery of efficient and high-quality services, and the services sector provides critical services (e.g., financial, transportation, design, supply chain) that enable the production, distribution and consumption of effective and high-quality products (Tien, 2007). However, the demarcation between the different economic sectors is not clear, which is especially true between the interdependent manufacturing and services sectors (Berg et al., 2001; Tien & Berg, 1995).

The majority of studies on the NIS have focused on the manufacturing sector, and hence, most of the policies are directed towards the manufacturing sector. However, the importance of the services sector cannot be overstated. It employs a large and growing proportion of workers in the industrialised nations (Tien, 2007). Tien (2007) also quoted the United States of America as an example that shows that the services sector comprises a large number of industries. Indeed, services contributed 82.1 percent of employment in the U.S., while the next four most significant economic sectors (i.e., manufacturing, construction, agriculture, and mining)together can be considered accounted for only 21.4 percent of employment. In most of the developing countries, the services sector plays a vital role contributing to GDP. Therefore, Pavitt (1984) posited the importance of sectors in innovation systems based on the idea that policy implications should be different for each sector. Heterogeneity of the sectors in Innovation Systems is also highlighted and emphasised by Breschi and Malerba (1997), Lundvall (2007) and Lee and Malerba (2017). Inter-sector differences play a significant role in shaping the NIS. Firms belonging to different sectors differ in their innovation processes and how they innovate, interact with other firms and knowledge infrastructure and draw upon markets for labour, finance and intellectual property (Lundvall, 2005). Therefore, sectoral differences can explain firms' response to national contexts, their innovation attributes and outcomes, which are critical to inform governments and policymakers. These differences justify the relevance for extending the understanding in this aspect. The following topic adds further policy justifications for the research.

1.3.2. Policy Considerations

Scholars in NIS literature believe that governments play a crucial role in orienting and funding innovation, at least at the national level, and particularly in the areas of innovation policy, academic and technological research, and higher education (Niosi, 2011). Nevertheless, it lies on the firm's innovative activities and routines. There are scholars, especially Teubal (1996) and Niosi (2010), who indicate that governments may influence the choice of routines that firms adopt. Well-designed innovation policies should induce innovating routines in firms. However, Edquist (2011) pointed out that designing and implementing innovation policy is not an easy task. Emerging economies are in a position to promote or build NIS for catching-up purposes. NIS approach is not only an analytical concept but also a tool to inform innovation policy developers for economic development (Lundvall, 2007). The author also added that in an attempt to inform governments on innovation policy design, the concept enables governments to promote innovation systems in developing countries. Therefore, promoting or building NIS using informed innovation policy in developing countries is worth adding to the NIS literature. This study builds upon the notion of the innovation policy that has emerged in the recent two decades following the dissemination of the NIS approach (Klochikhin, 2012; Metcalfe, 2005; OECD, 1997; Smits & Kuhlmann, 2004) and justified the research from a policy perspective. From scholarly discussions, the following three aspects of NIS are critical for policy purposes.

The first gap discussed here regarding NIS's policy contribution is related to the empirical studies and the measurements used in these studies. According to Smith (2000), it is essential to draw on the empirical evidence before turning to a discussion of policy foundations. It is essential to demonstrate practical relevance of a concept to consider it useful for policy purposes. Concrete empirical analyses are necessary for the design of specific policies for innovation (Edquist, 2002). The author also indicated that an innovation system approach is an analytical approach suited for such analyses. However, there are challenges in the empirical understanding of the NIS. Much of the work so far has been a description of National Innovation System's formal organisations directly contributing to the Science, Technology and Innovation (STI) mode of innovation sometimes combined with reports on STI policy (Lundvall, 2007). Another criticism of National Innovation Systems is that statisticians do not have the appropriate tools to measure the concept (Godin, 2007). Samara et al. (2012) categorised the studies carried out by using NIS approach and concluded that studies using empirical data to measure the NIS is scarce. Most of the empirical wor looked into factors using aggregate indicators that affect convergence and divergence patterns in broad cross-country assessment (Castellacci, 2008; Castellacci & Natera, 2013; Fagerberg & Verspagen, 2002; Fagerberg, Srholec & Knell, 2007; Fagerberg & Srholec, 2008; Lee & Kim, 2009).

Chaminade et al. (2012) highlighted several attempts to describe NIS rather than to define and measure NIS. Among the 24 studies reviewed related to evaluating NIS (and presented in the literature review chapter), only five attempted to evaluate or measure

NIS in emerging economies. Among them, three were qualitative, one was a simulation, and another one was quantitative. Among the three qualitative studies, Liu and White (2001) studied China's NIS in transition. Chang and Shih (2004) compared the innovation systems of Taiwan and China, while Intarakumnerd et al. (2002) attempted to understand the NIS of Thailand to understand developing countries, which are less successful in technological catch-up. Liu and White (2001, p.1112) concluded that it was 'far from clear that evolving into an innovation system similar to that found in developed market economies is a possible or even advisable objective for China or other countries emerging from central planning regimes, such as the former the Soviet Union'. Chang and Shih (2004) assessed NIS based on institutions covering institutional functions and interactions of institutions. These two studies provide explanations at the macro level. Another qualitative study by Intarakumnerd et al. (2002) used firms' perspective and firm-level data, which concluded that there is a mismatch between the level of economic structural development that is based on the development level of the NIS in emerging economies. A simulation exercise carried out by Lee, and Von Tunzelmann (2005) in Taiwan was based on data drawn from the Integrated Circuit (IC) industry. Another quantitative study by Chaminade et al. (2012) measured NIS regarding systemic problems. Policy approaches based on such studies end up being one-size-fits-all-policies rather than policies that take the specificities of the system into account. These discussions also raise concerns over the potential differences between developed and emerging economies. However, empirical research considering these differences for a comprehensive and whole systems analysis for policy design is scarcely covered in the literature. This gap poses challenges to governments in devising innovation policies that take account of these differences.

Studies by Chaminade et al. (2012) on Thailand and Srholec and Verspagen (2008) on Europe have sought to determine the factor structure of NIS empirically. However, these two studies mainly looked into systemic problems and firms' innovation strategies respectively. Srholec and Verspagen (2008) extracted 13 first-order and 4 second-order factors. The second-order factors extracted relate to research, user, external, and production strategies for innovation. Chaminade et al. (2012) extracted 16 first-order and 4 second-order factors. The second-order factors extracted relate to problems related to institutions, science and technology infrastructure, network and support services. These studies differed considerably regarding the outcome, which leaves a gap in the understanding and measurement of NIS. Also, these studies established differences in the NIS neither between emerging and developed countries nor between manufacturing and services sectors.

The second gap relates to the interrelationships among the constituents of NIS and innovation outcomes. The innovation process may be seen as an intricate interplay between micro and macro phenomena where macro-structures condition micro-dynamics and vice versa as new macro-structures are shaped by micro-processes (Lundvall, 2007). Smith (2000) also has a similar view indicating that innovation involves complex interactions between a firm and its environment that constitutes of broader factors shaping the behaviour of firms. Environmental conditions are often seen as specific to regional or national contexts, but they are also dynamic. However, past findings on innovation systems have revealed lack of clarity on how the firm (or micro) level, the sectoral (or meso) level and the national-regional (or macro) level interact (Reinstaller, 2007; Trigkas, Papadopoulos, & Karagouni, 2012) to explain NIS. This understanding is essential to influence innovation outcomes through relevant policies. There is much work to do to model, measure and compare such processes to inform policy devisors. As Edquist (2005) suggested, there is an urgent need for greater integration between conceptual and empirical studies of NIS for practical application regarding devising innovation policies. These discussions justify the need for an at least specific understanding of interrelationships in NIS via empirical means.

The third gap that has policy implications in devising innovation policy for building NIS relates to the identification of systemic problems or issues and enablers. Mostly literature discusses more the systemic issues than the enablers. Studies of Hekkert, Suurs, Negro, Kuhlmann, and Smits (2007) and Bergek, Jacobsson, Carlsson, Lindmark, and Rickne (2008) highlighted that success in the appropriation of innovations is to a large extent determined by how the innovation system is built up. Hence, NISs must be studied in greater depth through a profound understanding of their failures and starts to understand the most effective ways of building them (Niosi, 2011). However, issues that significantly impede development and diffusion of innovations characterise most of the innovation systems. These issues are often labelled as system failures or system problems (Hekkert, Negro, Heimeriks, & Harmsen, 2011). Therefore, studies on NIS approach has led to the emergence of literature on systemic problems that prescribes to policymakers the need to repair the constituents of the entire NIS rather than be guided by the simplistic market failure approach (Klochikhin, 2012; Smits, Kuhlmann & Teubal, 2010).

Smith (2000) highlighted the need for system theories that emphasise the decisive impact of system conditions on the extent to which firms can make innovation decisions, and on the modes of innovation. The actors within a system, as well as contextual factors, are all important constituents of any given system for the creation and use of knowledge for economic purposes (Sharif, 2006). The evaluation of systemic problems is critical for proactively stimulating, and thus, prioritising specific innovation activities to move in the direction of desired long-term transformative change (Weber & Rohracher, 2012). Therefore, intelligent, evidence-based innovation policies are required to create insights to system problems and act accordingly (Hekkert, Negro, Heimeriks, & Harmsen, 2011; Smits & Kuhlmann, 2004; Woolthuis et al., 2005;). Edquist (2002) also indicated that by empirically analysing the innovation system framework, it is possible to identify specific problems of innovation policy. Tien (2007) highlighted that in trying to identify innovation enablers (or barriers), there might be differences between those for goods (manufacturing) and those for services. Nelson (2008) had offered the evolutionary perspective on this by stating that innovation drivers differ with industry, time and location. Enablers and problems exist in the systemic constituents of the NIS, and the knowledge of these (in the empirical sense) is critical for policymakers to make informed decisions. Although some potentially major problems in the system are related to the constituents of the system (organisations, institutions or relationships), none of the studies hitherto offer any empirical evidence of such problems or suggest how they can be identified empirically (Chaminade et al., 2012). These considerations justify the need for empirical investigation of issues related to the systemic constituents of NIS regarding national contextual aspects and firm attributes.

Therefore, extending knowledge in the aspect of NIS for an emerging economy is of theoretical and policy relevance. The following section discusses the scope of the study.

1.4. The scope of the Study

This study aims to unravel the concept of NIS in firms' activities by investigating empirical evidence for patterns of firm attributes and context in which they function. This study further searched for evidence of systemic issues and complex interrelationships between firms and their contexts in realising innovation outcomes. The following assumptions set the scope of the study.

The first assumption is about the policy relevance of the concept. The NIS approach is practically relevant and useful in developing and reviewing policies (Edquist, 1997; Edquist & Hommen, 1999; Furman et al., 2002; Lundvall, 2007; Smith, 2000). Smith (2000) points this out by founding it on two strong hypotheses. 'The first is that innovation is a pervasive phenomenon, central rather than marginal to the operations of firms. The second is that interactions between firms, and between firms and other knowledge-producing agencies, are central to innovation performance. Both of these propositions receive some support from available data on innovation'. Also, the NIS concept has received wide currency in both academic and policy-making contexts (Sharif, 2006). The concept is also considered a useful and promising analytical tool for academic study and innovation policy-making, fostering an understanding of innovation processes and determinants (Edquist, 1997; Furman et al., 2002; Lundvall, 2007; Guan & Chen, 2012) for governments, firms and sectors.

The second assumption is about the characteristics of the concept. In general, Innovation has systemic and evolutionary characteristics (Edquist, 1997; OECD, 2007) and past choices invariably impose constraints but contribute to innovation (Dosi, 1988; Nelson & Winter, 1982; OECD, 2007). Therefore, this study views the NIS concept from the evolutionary perspective. Also, the concept of NIS and several of its characteristics (irreversibility, path dependency, multi-stability) are consistent with the evolutionary theory of economic activity and follow more naturally from evolutionary theories than from orthodox economics (Chaminade & Edquist, 2006; Johnson, 1997; Niosi, Sa, Bellon, & Crow, 1993). The real scenario is that policymakers have insufficient information about the system of innovation that produces innovation outcomes. Therefore, devising policies for national innovation outcomes is not an easy task. These considerations lead to a question on how nations or governments with many varied evolving scenarios within and around them can update themselves to devise policies so that they can frame relevant policies to influence innovation outcomes. The epistemological problem here includes, how is it possible to capture holistic, open-ended and context-sensitive issues to enhance innovation outcomes for economic growth. This situation is similar to the frame problem that was defined by Mccarthy and Hayes (1969) to highlight a philosophical problem from the standpoint of Artificial Intelligence. The frame problem is a problem of locating a set of hypotheses or propositions that are being established, accepted and regarded true for a feasible or practical description of an evolving environment. Devising policies for innovation is one such problem and for Fodor (2000), solving such a problem is an epistemic commitment to guarantee that epistemologically relevant matters are not missed out. When such a frame problem exists, Chow (2011) recommends invoking heuristics, which suggest ways to identify and circumvent problems using available information (Carruthers, 2006; Samuels, 2005).

As Chow (2011) had indicated, heuristic concepts are tools for real-world problems, such as taking a job offer, devising a feasible policy, solving a murder case that is characterised with undefined or uncertain situations and problem spaces that cannot be entirely or adequately known, understood or characterised. These tools are not meant for producing correct outcomes or optimised operations. Metcalfe and Georghiou (1998) indicated that the evolutionary process is characterised by a large extent of trial and error. This study is firmly founded on the belief that looking for guaranteed correct outcomes and optimised operationalisation will neglect sensible scholarly quest for practical issues and trivialise interesting features of reality in devising policies for innovation. Therefore, this study considers NIS as a heuristics concept in a policy context that enables to unravel resources, such as a theoretical framework and findings that researchers can draw upon to add variations in understanding and formulate techniques to their subsequent enquiries.

This study takes the third assumption that considers 'nation' as the appropriate unit to discuss innovation systems to organise it for national benefit. This approach had nothing specific to a spatial aspect, but, scholars in this field (Edquist, 1997; Lundvall, 1992; Nelson, 1993; Nelson & Rosenberg, 1993) have considered in many cases the set of firms, organisations and institutions involved in the innovation system as a sort of 'national' community. The OECD (2007) and Lundvall (2005) pointed out that the notion of NIS is to describe the way particular national institutional frameworks condition the evolutionary technological dynamics of the national economy. In particular, this is often enabled by the signals and incentives that national level regulation and policy implementation provides for the pursuit of innovative activity. OECD (2007) also indicated that the NIS literature deals with the historical effects of national-level regulation and institutions in the broader sense of economic decisions made by firms. An innovation system may be delimited nationally (regionally), sectorally, or according to the technology or knowledge base based on the issue to be addressed. These determinants of limits are mutually complementary and may be applied individually or in combination based on the object of the research (Andersen, Andersen, Jensen, & Rasmussen, 2014).

According to Williamson (1975), regulations and institutions help to promote innovation by removing uncertainties and allowing firms to best benefit from market and hierarchy forms of economic organisation, avoiding both bureaucracy and priceless information. Therefore, Freeman (1994) argued the 'nation' as the appropriate unit to consider because there are considerable national differences that shape the innovation process into national trajectories and produce a variety of different national economic outcomes. These arguments posit the importance of national unit for policy formulation and direct the innovation initiatives of firms towards intended national outcomes.

The next assumption that sets the scope is that the NIS requires being studied, as a whole in a broader sense and the appropriate observations available for this purpose is the data from innovation surveys. The reason is, attempts to initiate catch up strategies should start with the mapping of firms, institutions, their policy frameworks and integration with markets (global and local) (Rasiah, 2011a) and in general all about firms and their contexts around in which they work. As Hekkert et al. (2011) had noted, innovation is a collective activity. It takes place within the context of a wider system. This broader system is termed as 'the innovation system' or 'the innovation ecosystem'. Lundvall (2005) suggested taking into account how 'the wider setting' affects what is going on at the core of the system. The author also emphasised that this is especially important when the object of analysis is an emerging national system of innovation and competence building. However, the NIS is criticised by statisticians because the concept did not have the appropriate tools to measure it. Smith (1995) and Lundvall (1992) agree to that criticism. Smith (1995, p.70) had noted that "There are no straightforward routes to empirical system mapping: we have neither purpose-designed data sources nor any obvious methodological approach". Lundvall (1992, p.6) emphasised that 'the most relevant performance indicators of National Innovation System should reflect the efficiency and effectiveness in producing, diffusing and exploiting economically useful knowledge and that such indicators are not well developed today'. Therefore, David and Foray (1995) and Lundvall (2007) suggest that the most efficient way to enhance the analytical capacity of the NIS concept is to use it as a framework for empirical work making creative or direct use of what is available and known. The Community Innovation Surveys (CIS) done at the national levels is one available option of empirical evidence that covers a wider aspect of NIS from the firms' perspective. Also CIS provides the much needed broader view of innovation than the traditional Research and Development (R&D) based framework (Smith, 2004). This broader view includes different innovation outputs, a range of innovation inputs in addition to R&D, as well as data on sources of information for innovation, cooperation partners and protection of intellectual property (Srholec & Verspagen, 2008). Being the core of the NIS, firms' views of NIS regarding their activities and contexts are crucial for devising policies for national benefit. Hutschenreiter (2013) who observed the OECD reviews of innovation policies highlighted that there is an international trend of moving towards more firm-centred innovation systems. He showed evidence of this trend in the countries with successful innovation systems such as Switzerland, Austria, Denmark, Finland, Germany, and Korea. Innovation surveys are based on firms' perspectives. An exploratory analysis to examine the variables in the Innovation Surveys, their relationship with innovation outcomes and the interrelationships among them have the potential to reveal new and more conceptually valid factors and models to explain NIS from firms' perspective.

In so doing, this study adopts the definitions advanced by Lundvall (1992) on NIS, and contributions of Freeman and Soete (1997), Hartley (2005) and Albury (2005) for innovation, Edquist, and Hommen (2008) for the system to operationalise the study aims. The definitions of these concepts are discussed under the topic 'definitions' later in the chapter. Based on the theoretical and policy justifications for the research and scope discussed, we have to study an emerging country, in which firms play a critical role as innovation agents for economic growth. The research context below discusses it.

1.5. Research Context

Several economies in South-East Asia recorded rapid industrialisation since the 1970s (Singapore, Malaysia and Thailand) and 1980s (Vietnam) due to the opening of many free trade zones and inflow of foreign direct investment (FDI). According to Wong (2011), these emerging economies in South- East Asian countries belong to the downstream segment of the global industrial system with a heavy emphasis on high-technology and export-oriented industry. He also indicated that these countries are characterised with the traditional emphasis on institutions that facilitate technology diffusion and industrial development. National institutions of these countries also orientate and adjust to policy changes on its market exchange rate reforms and consolidation of its state-owned enterprises for learning capabilities building over the decades to reinforce the development of a market economy. Policies play a significant role in the countries of this region in orientating and adjusting firms to contribute to the intended national outcome. Among Southeast Asian countries, Malaysia ranks second after Singapore in economic competitiveness (OECD, 2013). However, an OECD (2013) review on Malaysia's innovation profile highlighted that innovation is very critical for Malaysia, as the economic recovery of Malaysia has been persistently slow since the Asian economic crisis of 1997. The report highlighted that there is a reason to fear that Malaysia might catch up in a 'middle-income trap'. This fear is due to relatively slow growth in Research and Development (R&D) and innovative capacity over an extended period, lack of coordination between national Science and Technology (S&T) policy and firms, weaknesses in the implementation of strategies, lack of private investment in domestic economy, stagnating productivity growth, and lack of competitiveness. Based on these, OECD called for Malaysia to have a strong emphasis on innovation as a driver for economic growth.

In the 1990s, Malaysia launched its first S&T policy as the way forward with a focus on R&D incentives to support innovation (Rasiah, 1999). This supply push without the consideration of the system as a whole failed to address the intention to increase innovation (Wong, 2011). There are promising signs in terms of growth of science and technology as indicated by the number of papers and patents (Wong & Goh, 2010; Wong, Thirucelvam, & Ratnavelu, 2010), but, the innovation and patent production are still quite small, and the growth of learning capabilities is still weak comparatively in longer-term perspective (OECD, 2013; Wong, 2011). Based on OECD reviews on Malaysia, Hutschenreiter (2013) recommends that by increasing innovation capability and performance, Malaysia has the potential to contribute towards shifting the Malaysian economy towards a new model of sustainable growth and inclusive development. Innovation would help raise productivity and competitiveness of firms and make Malaysia an active player in knowledge-based activities in rapidly evolving and interlinked world systems. Therefore, NIS could be the best analytical tool to assess the situation for innovation outcomes to make informed policy actions.

Very few studies cover NIS in South East Asian emerging economies notably on Malaysia (mainly by Rasiah (1999), Felker (1999), Wong (1999), Asgari and Wong

(2007), Wong (2011), Chandran, Sundram, & Santhidran (2014) and UNESCO (2015)) Thailand (mainly by Intarakumnerd et al. (2002), Intarakumnerd (2006), Intarakumnerd and Chaminade (2007)) and Vietnam (by Bezanson, Annerstedt, Chung, Hopper, Oldham and Sagasti (1999)). Based on Wong (2011), studies carried out on these countries indicated that Southeast Asian Innovation Systems are weak and highly fragmented from the production structure of the economy and experienced the minimal progress of industrial technology since the turn of the millennium. These studies shed some light that Science, Technology and Innovation (STI) policy on the linear model of innovation, incompetent bureaucracies and lack of complementary investment for innovation has impeded Southeast Asia's national innovation outcomes. Prospects for economic development based on knowledge seem to be challenging without reforming or uprooting the entire institutional structure of governance for the innovation system. Consequently, Southeast Asian economies, including Malaysia and Thailand, have been facing a slowdown in industrial value added owing to slow technological upgrading in the face of rising competition from China and Vietnam and a lack of development for the productive local-owned firms (the national champion firms) (Wong, 2011). Mainly, the technological learning in Malaysian firms is via the interaction of foreign subsidiaries and not the universities (Chandran et al., 2014). This import of technology compared to development in collaboration with science parks and universities has an impact on local innovations. In general, due to infrastructural, institutional and market issues, firms in Malaysia are challenged in their innovativeness and subsequent technological upgrading. These issues are typical situations of emerging nations as indicated by Lundvall (2007). Since Malaysia is a market economy; firms need to play the role of innovation agents as indicated by Whitley (2007) for growth and development. Furthermore, the manufacturing and services sectors play dominant roles in Malaysia's economy (Fauzi & Chee, 2013). The sectoral outputs of Malaysia show that the services sector is the most significant contributor to the economic growth of Malaysia. However, national policy has focused more on manufacturing than services in Malaysia.

The case of Malaysia has revealed that the country has neither technologically sophisticated local industry nor is a hotbed of scientific production (Wong et al., 2010). They also warned that the situation might get worse if there is no progress in Malaysia's innovation system (capability-building efforts). Wong and Goh (2010) argue that Malaysia as an emerging economy has the opportunity to respond to new technological paradigm to compete in the global environment. It is time for Malaysia to realise that policies based on markets or direct application of policies from developed economies will not result in intended outcomes when it comes to innovations. There is an opportunity for the government to devise policies to shape national innovation outcomes for national benefit by taking advantage of the NIS framework with a profound understanding of firms and sectors within Malaysia. Malaysia has carried out innovation surveys since 1998. Chandran et al. (2013) studied the national innovation system of Malaysia through university-industry collaboration and argued that due to the weak industrial R&D landscape, the policy should focus on upgrading the industrial R&D activities (demand side). Technology-push strategies are not very useful as the industries are not in a position to absorb the new knowledge created by the universities. Chandran and Rasiah (2013) attempted to explain the interrelationships in the national innovation system of Malaysia. They investigated the relationship of technological capability and size with innovation (firms' economic performance) in Malaysia. The study indicated that technological capability of firms, directly and indirectly, influences the performance, while size influences both technological capability of firms and performance. However, there is a need to consider the elements of NIS comprehensively. One of the main thrusts of innovations in Malaysia, as stipulated in the national innovation strategy of Malaysia, is to strengthen the building blocks of innovation (Agensi Innovasi Malaysia, 2011). The data from the survey can be of help to understand the Malaysian NIS with insights into Malaysian firms and sectors. Despite certain scholarly work done in this area as discussed, scant knowledge exists on how these systemic aspects shape the core players of the innovation system and firms' perspectives influence the innovation outcomes of the nation. Therefore, Malaysia would be a good example to test the NIS in emerging economies.

1.6. Research Model

Based on the literature review and theories reported in chapter 2, the constituents or dimensions of NIS and a research model depicting the interrelationships among the dimensions leading to innovation outcomes are developed. Figures 1.1 and 1.2 present the proposed measures and research model. Six major measures or dimensions of NIS leading to innovation outcomes are apparent from the literature and are infrastructure, institution, market factors, firm capability, interactions and transformational factors. These dimensions were prominent with 21 sub-dimensions as per the literature discussed in chapter 2 and presented in figure 1.1.

The two major constituents of NIS national contextual factors and firm attributes were developed based on the arguments of Carlsson at al. (2002) and Edquist and Hommen, (2008) for national contextual factors, and Lundvall (2007), Whitley (2007) and Weber and Rohracher (2012) for firm attributes. For the dimensions from the viewpoint of promotion or construction, this study considered the perspectives of Carlsson at al. (2002), and Edquist and Hommen (2008). Sectors are heterogeneous within the national context. Based on Breschi and Malerba (1997) and Lundvall (2007), this study considers that the sectoral perspective makes the general understanding of innovation in firms better in its own right within the national context.

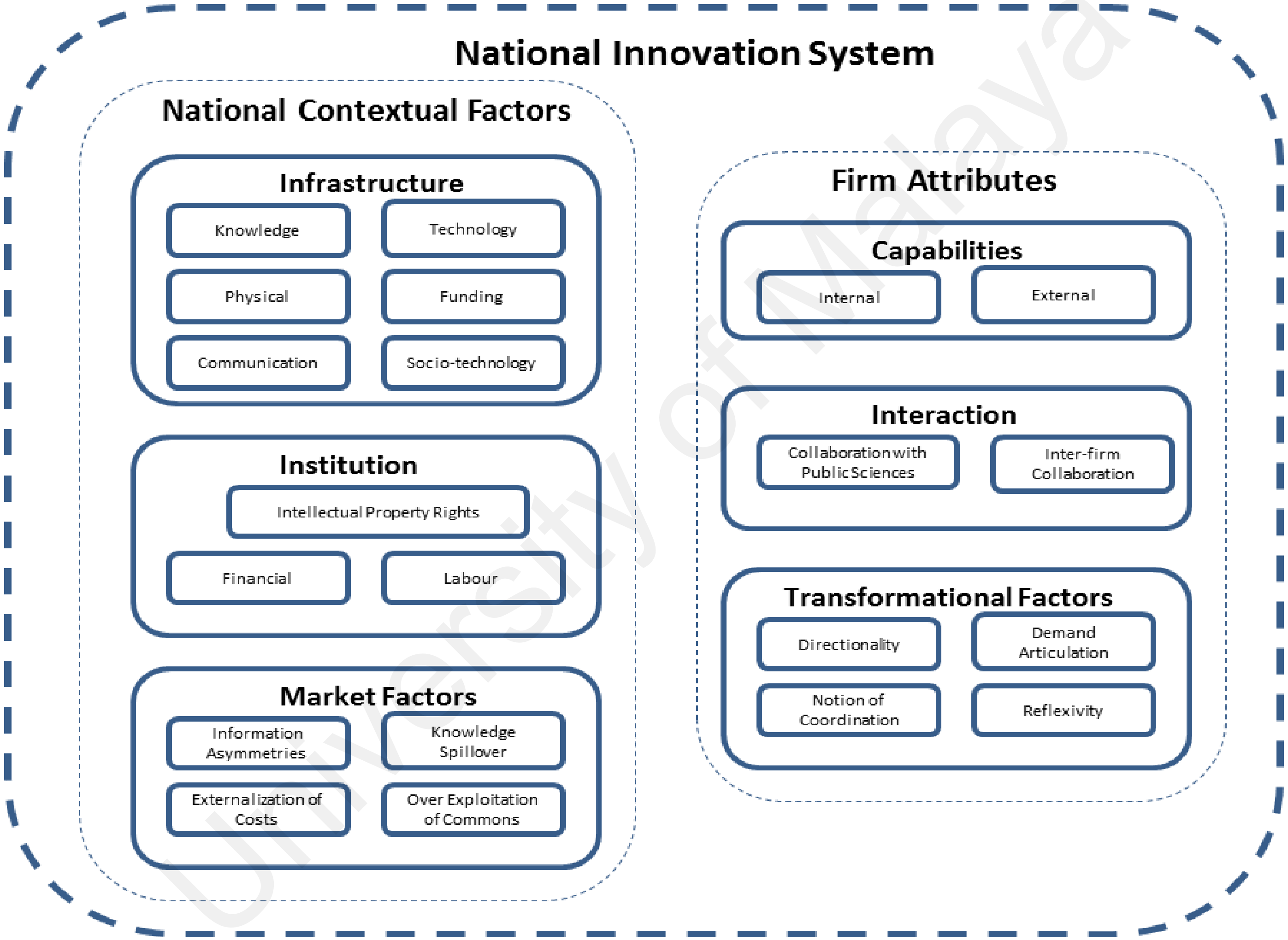

Figure 1.1: Proposed Dimensions and Sub-dimensions of National Innovation System

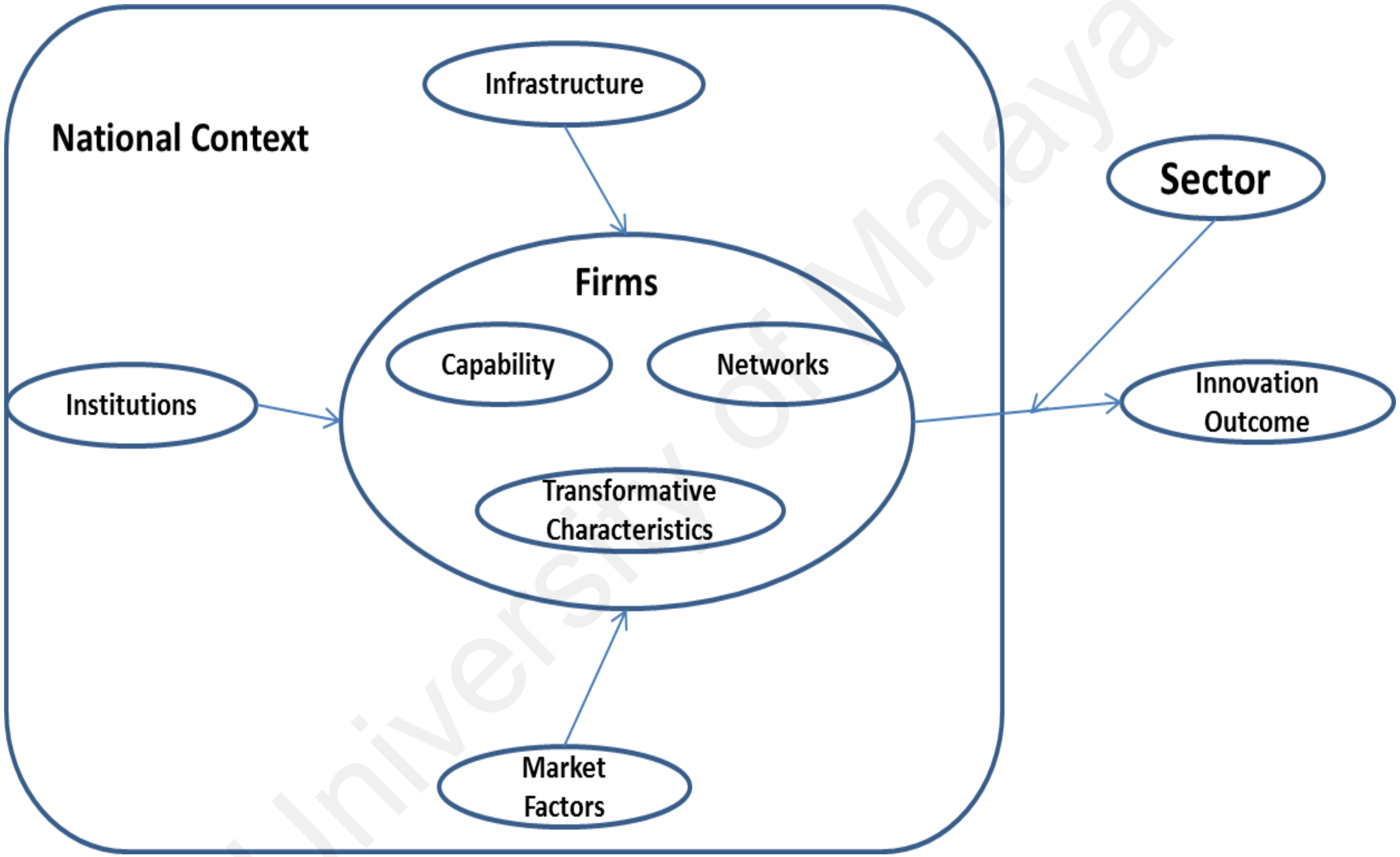

Figure 1.2: Proposed Research Model

1.7. Research Questions and Hypotheses

The literature review in chapter 2 explains the existence of multidimensional hierarchical factor structure (latent constructs) of firm attributes and national context in the observations of firms' innovation activities representing NIS. Also, the possibility to unravel the systemic problems and enablers from these dimensions, and the inter-relationships among the dimensions of national contexts, firm attributes and innovation outcomes. However, it can be observed that researchers of NIS have not been entirely successful in explaining empirically NIS in its multi-dimensions, systemic enablers and problems regarding its dimensions, interrelationships of these dimensions as well as the concepts' unique aspects in emerging economies from the perspective of firms. This gap in knowledge about the microstructures challenges the manipulation of institutions and infrastructures at the meso- and macro-level for betterment. This study attempts to reduce rather than eliminate this gap. Therefore, the overall aim of this study is to explore the constituents and measures of NIS, their relationship to the innovation outcomes and systemic issues in realising the innovation outcomes. The research gaps discussed lead to the following specific research questions.

- What are the prevalent constituents or dimensions of NIS regarding firm attributes and their contexts in emerging economies? How do these dimensions differ between manufacturing and services sectors?
- What are the systemic problems and enablers of innovation of firms in NIS of an emerging economy? How do they differ between manufacturing and services sectors?
- What are the relationships among national contextual factors, firm related

factors and innovation outcomes? How do the relationships differ between manufacturing and services sectors?

Considering the overall aim and research questions of this study, the specific research objectives of this thesis are to:

- Explore the constituents and dimensions of NIS regarding firm attributes and their contexts in emerging economies and compare manufacturing and services sectors;
- Investigate the systemic problems and enablers of innovation of firms in NIS of an emerging economy and compare manufacturing and services sectors;
- Examine the relationships among national contextual factors, firms related factors and innovation outcomes, and compare manufacturing and services sectors.

The proposed research model considers the firm as the core of NIS, which is conditioned by the national context to influence innovation outcomes for economic benefit following the arguments of Smith (2000), Lundvall (2007) and Patana et al. (2013). Hence, to address the research question related to the measures and dimensions of NIS in an emerging economy and the differences between the sectors, the first hypothesis was set to unravel the hierarchical factor structure (latent constructs) of the firm and national context-related factors in the manufacturing and services sectors. The second hypothesis focused on assessing the enablers and problems of NIS in the manufacturing and services sectors. The third hypothesis set out to explore the direct and indirect relationships among national contextual dimension, dimensions of firm attributes and innovation outcomes. The proposed hypotheses are based on the supporting evidence that is presented in the literature review (chapter 2). Table 1.1 shows a summary of the hypotheses developed for this study.

Table 1.1: Summary of Problem Statement, Research Questions and Hypotheses

Problem Statement	Research Questions		Research Hypotheses	
It can be observed that researchers of NIS have not been entirely successful in explaining NIS empirically in its multi-dimensions; systemic enablers and problems regarding its dimensions; interrelationships of these dimensions; as well as the concepts' unique aspects in emerging economies from the perspective of firms. This gap in the knowledge about the microstructures challenges the manipulation of institutions and infrastructures at the meso- and macro-level for betterment. This study attempts to reduce this gap.	***RQ 1.0:***	***What are the prevalent dimensions of NIS regarding firm attributes and their contexts? How do these dimensions differ between manufacturing and services sectors?***	***$H_{1.0}$:***	***There exists an underlying hierarchical factor structure (latent constructs) of the firm and national context related dimensions in the observations of firms' innovation activities within NIS.***
	rq 1.1:	*What are the prevalent dimensions of NIS regarding firm attributes and their contexts in the manufacturing sector?*	*$H_{1.1}$:*	*There exists an underlying two-level factor structure of the firm and national context related dimensions in the observations of firms' innovation activities in manufacturing sector within NIS.*
	rq 1.2:	*What are the prevalent dimensions of NIS regarding firm attributes and their contexts in the services sector?*	*$H_{1.2}$:*	*There exists an underlying two-level factor structure of the firm and national context related dimensions in the observations of firms' innovation activities in services sector within NIS.*
	rq 1.3:	*How do the dimensions of NIS regarding firm attributes and their contexts differ between manufacturing and services sectors?*	*$H_{1.3}$:*	*Firm and context related dimensions within NIS differ between manufacturing and services sectors.*
	RQ 2.0:	***What are the enablers and barriers to innovation for firms in NIS of an emerging economy? How do they differ between manufacturing and services sectors?***	***$H_{2.0}$:***	***The dimensions of NIS regarding firm attributes and their contexts have a significant effect on innovation outcomes as an enabler or as a problem***
	rq 2.1:	*What are the enablers and barriers to innovation for firms in manufacturing sector within NIS?*	*$H_{2.1}$:*	*The dimensions of NIS regarding firm attributes and their contexts have a significant effect on innovation outcomes in the manufacturing sector.*
	rq 2.2:	*What are the enablers and barriers to innovation for firms in services sector within NIS?*	*$H_{2.2}$:*	*The dimensions of NIS regarding firm attributes and their contexts have a significant effect on innovation outcomes in the services sector.*

Problem Statement		Research Questions		Research Hypotheses
		'Table 1.1, continued'.		
	rq 2.3:	*How do the enablers and barriers to innovation differ between manufacturing and services sector?*	*$H_{2.3}$:*	*There is a difference between manufacturing and services sectors in the direct influence of firm attributes and their contexts on innovation outcomes in NIS.*
	RQ 3.0:	***What are the relationships among national contextual factors, firm related factors and innovation outcomes? How do they differ between manufacturing and services sectors?***	***$H_{3.0}$:***	***The effect of NIS contextual factors on innovation outcomes is intervened (mediated) by firm attributes***
	rq 3.1:	*What are the relationships of firm attributes and contextual factors with innovation outcomes in the manufacturing sector?*	*$H_{3.1}$:*	*The effect of NIS contextual factors on innovation outcomes is intervened (mediated) by firm attributes in the manufacturing sector.*
	rq 3.2:	*What are the relationships of firm attributes and contextual factors with innovation outcomes in services sector?*	*$H_{3.2}$:*	*The effect of NIS contextual factors on innovation outcomes is intervened (mediated) by firm attributes in the services sector.*
	rq 3.3:	*How do manufacturing and services sector differ in the relationships of firm attributes and contextual factors with innovation outcomes?*	*$H_{3.3}$:*	*There is a difference between manufacturing and services sectors in the effect of NIS contextual factors on innovation outcomes intervened (mediated) by firm attributes.*

1.8. Methodology

This study seeks to unravel the dimensions of NIS and evaluate the relationship between variables through systematic and scientific methods. Therefore, the most suitable paradigm to guide this study is the positivist research paradigm. The reason is, this study looks for truth or knowledge based on verified hypotheses with the belief that reality exists by the unchangeable natural cause-effect laws and therefore, the reality is independent of the researcher. Further, this study integrates different perspectives for hypotheses development and testing to determine the phenomena of NIS in emerging economies and to validate and generalise the proposed perspective. The philosophy within the positivist paradigm that guides the study is objectivism, and the research design that employs quantitative methods is most suitable. This study is required to uncover variables and test theory through the exploration of the relationship between variables. Therefore, the analytical survey is useful. Analytical surveys also allow for generalisation of research findings to the population as this approach is highly structured and conducted on a random set of samples. The study also employed an ex-post facto design guided by theoretical and empirical findings. Newman and Newman (1994) pointed out that the most effective use of an ex-post facto design is to help identify a small set of variables from a broad set of variables related to the dependent variable for future experimental manipulation.

This study used five stages of the research processes involving a problem, hypothesis, research design, data analysis, and generalisation except for the measurement and data collection stages as the study used the national innovation survey data. For the analysis, this study used the data from the 2012 National Survey of Innovation, Malaysia, which is the sixth in the series for Malaysia, covered the period from 2009 to 2011 following Oslo's Manual of the year 1992. 2012 National Survey of Innovation is the latest national innovation survey data available in Malaysia as of 2nd April 2017. The sample of innovative firms provided by MOSTI was 1178 (n) that consisted of the subsamples of manufacturing and services sectors with a sample size of 445 and 733 respectively. This study employed descriptive analysis by using IBM Statistical Package for the Social Sciences (SPSS) 21, hybrid factor analytic model to unravel first- and second-order dimensions using SPSS 21 and factor validation by SmartPLS 3.0. Also, the study used Partial Least Squares Structural Equation Modelling (PLS-SEM) method by SmartPLS 3.0 to test the developed structural models (a) for the systemic enablers or problems in terms of national contexts and firm attributes and (b) for the indirect effect of national contextual factors on innovation outcomes through firms' attributes.

1.9. Definitions

As the definitions of terms may vary, this section provides the definitions of fundamental concepts of this thesis to establish a common understanding and to reconcile any differences in the definitions.

National Innovation System

Several authors attempted to define NIS as listed in Table 1.2.

Table 1.2: Definitions of National Innovation System

No	Author	Definition
1	Freeman, 1987	"... The network of institutions in public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies."
2	Lundvall, 1992	"... The elements and relationships which interact in the production, diffusion and use of new, and economically useful knowledge... and are either located within or rooted inside the borders of a nation-state."
3	Nelson and Rosenberg, 1993	"... The set of institutions whose interactions determine the innovative performance of national firms."
4	Edquist and Lundvall, 1993	"... The national system of innovation is constituted by the institutions and economic structures affecting the rate and direction of technological change in the society."
5	Niosi et al., 1993	"... A national system of innovation is the system of interacting private and public firms (either large or small), universities, and government agencies aiming at the production of science and technology within national borders. Interaction among these units may be technical, commercial, legal, social, and financial, in as much as the goal of the interaction is the development, protection, financing or regulation of new science and technology."
6	Patel and Pavitt, 1994	"... The national institutions, their incentive structures and their competencies that determine the rate and direction of technological learning (or the volume and composition of change generating activities) in a country."
7	Metcalfe, 1995	"... That set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies."

Source: Niosi (2002, p.292)

From the definitions, one can realise that the definitions focus on either institutions or knowledge for innovation. This is also highlighted by Godin (2009, p.478) as, 'there are two families of authors in the literature on National Innovation System, those centring on the analysis of institutions (including institutional rules) describing the ways countries have organized their National Innovation Systems as indicated by Nelson (1993) and those who are more ‘‘conceptual,’’ focusing on knowledge and the process of learning itself such as learning-by-doing, learning-by-using, and so on as indicated by Lundvall (1992)’. The author also added that from the latter group, the concept of the knowledge economy, first suggested in the early 1960s, re-emerged in the 1990s.

Lundvall distinguished the definitions of NIS into narrow and broad definitions as indicated below:

> *The narrow definition would include organisations and institutions involved in searching and exploring such as R&D departments, technological institutes and universities. The broad definition . . . Includes all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring the production system, the marketing system and the system of finance present themselves as subsystems in which learning takes place* (Lundvall, 1992, p. 12).

The aim of the study is in-line with the original agenda of NIS and the view of (Lundvall, 2007b) regarding explaining or informing the macroeconomic aspects through the microeconomic activities. Therefore, the broad definition of NIS is suitable for this study. Consequentially this broader definition is based on a systemic approach rather than linear push and pulls processes (Marxt & Brunner, 2013). Based on the authors, the broader view also guides the movement from “Science Policy” and “Technology Policy” towards “Innovation Policy”. NIS is referred as both ‘National Innovation System’ (as advocated by Lundvall) and 'National System of Innovation (as advocated by Nelson). This study uses the term 'National Innovation System' (and in abbreviation as NIS).

Innovation

Innovation is one of the sub-concepts of NIS concept. Schumpeter is remembered whenever there is a discussion on innovation. According to Schumpeter, innovation specifies new products, new processes, new raw materials, new forms of organisation and new markets. The authors who had attempted to define and discuss the concept 'innovation' include Schumpeter (1942), Romer (1990), Freeman and Soete (1997), Gordon and McCann (2005), Freeman (1982), Drucker (1985), Albury (2005), and Hartley (2005). This study views innovation as the recombination of existing ideas or the generation of new ideas into new processes, products (Freeman & Soete, 1997; Gordon & McCann, 2005; Hartley, 2006)) and services or organizational forms (Albury, 2005), which result in significant improvements in outcomes, efficiency, effectiveness or quality (Hartley, 2006).

This study used the definition of Oslo Manual (OECD & Eurostat, 2005), which stated innovation as, 'the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations' (p.46). This manual further highlighted that there are broad and narrow definitions of innovation based on the types of innovations. Innovations are differentiated in various types: social, organisational, administrative or technical, incremental or fundamental, product or process (Jost, Lorenz & Mischke, 2005). While the broad one encompasses a wide range of possible innovations, the narrow one covers the implementation of one or a few of innovation such as product and process innovations. However, the manual also added that the broad definition might not be appropriate for policy and research purposes, as it would challenge comparisons across sectors and firms of different size categories. Scholars have also challenged the use of the narrow definition covering only product and process innovations in the earlier versions of Oslo manual by OECD. The reason is product and process innovations are in general associated with manufacturing sector involving high-tech industries. With the growing interest in services Sector and its escalating contribution to the economy, the narrow definition of innovation involving only product and process innovations becomes inappropriate to study the NIS. Therefore, the revised Oslo's manual indicated, 'the minimum requirement for innovation is that the product, process, marketing method or organisational method must be new (or significantly improved) to the firm. Innovations include products, processes and methods that firms develop as new and those that they adopt from other firms or organisations' (OECD & Eurostat, 2005, p.46). What is essential and familiar to most innovation definitions in business contexts is that innovation is understood as a process of a firm (Rametsteiner & Weiss, 2006).

System

'System' is another sub-concept of NIS. Lundvall (2007) referred this sub-concept 'system' to a few simple ideas. According to the author, the system is more than the sum of its parts, the interrelations and interactions between the elements are as important as the processes and outcomes of the NIS with its unique dynamics. Carlsson, Jacobsson, Holmén, and Rickne (2002) indicated that components, relationships, and attributes make up a system. According to the authors, from system engineering perspective, the system is a set of interrelated components working toward a common objective. Therefore, there is a need to understand the system as a complex aspect. Authors such as Lundvall (2007), Smith (2000), Bergek, Jacobsson, Carlsson, Lindmark, and Rickne (2008), Carlsson et al. (2002), and Edquist and Hommen (2008) and so on attempted to discuss and define the concept 'System'. This study considered the views of Edquist and Hommen (2008) and Carlsson et al., (2002) to define the concept 'system' for this study purposes. Based on these authors, a 'system' has three distinct features. They included two types of constituents (components and relations among them that form a coherent whole) and properties or attributes different from those of the constituents but dedicated to perform or achieve something and the possibility to discriminate between the system and the rest of the world (possibility to identify the boundaries).

Manufacturing Sector vs Services Sector

Tien and Berg (2003) provide a comparison between goods and services sectors. Based on the authors, goods sector requires material as input, is physical, involves customer at the design stage and employs mostly quantitative measures to assess its performance. On the other hand, the services sector requires information as input, is virtual, involves customer at the production and delivery stage and employs mostly qualitative measures to assess its performance.

The description of services sector by Quinn, Baruch and Paquette (1987) includes all economic activities whose output is not a physical product or construction, which are consumed at the time they are produced. Also, services sector provides added value in forms (such as convenience, amusement, timeliness, comfort or health) that are inherently intangible. Using this definition, (Tien, 2007) attempted to differentiate manufacturing and services sectors. Based on the author, production and services delivery are integrated and assumed as one and consist of combined stages of the value chain in the services sector. However, manufacturing or goods sector had distinguished production and services delivery stages and had detailed value chain that includes supplier, manufacturer, assembler, retailer, and customer. The author also indicated that services are co-produced, whereas goods have traditionally been pre-produced. All these descriptions and differences of manufacturing and services sectors are applicable for this study.

1.10. Outline of Thesis

This study consists of seven chapters. Chapter 1 presents the introduction, which covers the background to the research, statement of the problem, the justification for the research covering both theoretical and policy aspects, scope of the study, research context, brief introduction to research model, research questions and hypotheses, and definition of fundamental concepts. Chapter 2 discusses the literature review covering foundational theories of NIS concept; theories contributing to the dimensions of NIS; a review of past studies attempting to uncover the dimensions, systemic enablers and problems and interrelationships among the dimensions leading to the research model and hypotheses. Chapter 3 presents the Methodology detailing the paradigm that guides the study followed by research design and data analysis techniques. Chapters 4, 5 and 6 analyse the findings of the three hypotheses unravelling the first- and second-order dimensions of NIS; assessing the systemic enablers and problems; and the direct and indirect relationship of national contextual dimensions with the innovation outcomes. The last chapter (chapter 7), which is on conclusion covers a summary of the findings related to the research issue and linked to the boundaries of knowledge and theory discussed in chapter 2. The chapter also covers the implications of findings and conclusions for both theory and policy.

1.11. Summary

This chapter introduces the fundamentals of the study. The background of the research highlights escalating interest in NIS concept from scholars and emerging economies for catching-up purposes. Further, this chapter discusses the need to consider differences between developed and emerging economies for a comprehensive and whole NIS analysis for policy design for catching-up purposes and a need for developing a practically useful analytical framework that allows for the assessment of system performance. It also highlights the scarce literature and empirical studies available in this aspect leading to gaps in the understanding of the concept. These observations enable to develop the main and specific research questions. The chapter also discusses theoretical and policy considerations, the scope of the study, methodology in brief and definitions of fundamental concepts.

CHAPTER 2: LITERATURE REVIEW

This chapter provides a theoretical grounding for the study, identifies dimensions of NIS to conceptualise the research framework, and formulates hypotheses to test system promotion or construction viewpoint. The chapter begins with a consolidation of theories or perspectives that contributed to the theoretical origin of NIS followed by a brief discussion of specific theories and perspectives, which facilitated identification of different dimensions of NIS. The following sections cover literature related to dimensions of NIS, research framework and hypotheses to study the research objectives. The chapter concludes with a summary of hypotheses development.

2.1. National Innovation Systems for Policy Purposes

2.1.1. National Innovation System

National Innovation System (NIS) concept was initially developed as an alternative analytical framework to standard economic analysis, which neglected dynamic processes related to innovation and learning in analysing economic growth and development (Niosi, Saviotti, Bellon, & Crow, 1993; Edquist & Hommen, 1999; Lundvall, 2007; Godin, 2009). There is a considerable scholarly and practical interest in NIS considering its relevance for the economy. However, the concept of NIS was aimed at challenging standard economic theory not only due to microeconomic aspects of innovation but also about macroeconomic explanations of economic growth (Lundvall, 2007). In line with Lundvall, this study views NIS as a concept with constituents or dimensions that help shaping innovation processes and link innovation to economic performance. The aim of the study is in-line with the original agenda of NIS as indicated at the beginning of the topic and the view of Lundvall (2007) regarding explaining or informing macro-economic aspects through microeconomic activities. Therefore, the broad definition (provided in chapter 1) is suitable for this study.

The concept of NIS includes three sub-concepts within namely national, innovation and system. While chapter 1 covered sub-concepts 'innovation' and 'system', this section briefly discusses the concept 'national'. There is an argument that the sub-concept "national' might not be the adequate level of analysis for understanding the process of innovation as it is the most dubious aspect. However, Lundvall (2007) clarified the use of 'national' in NIS by indicating that Social Science has been operating mainly at the national level and this includes economic analysis where there has been a strong focus on comparing economic growth and wealth of nations. Innovation system at the national level is supported by Niosi et al. (1993, p.216) by specifying, 'although different NISs can achieve similar targets regarding the growth of output, productivity, and exports, they achieve them using institutional arrangements and interactions that are quite country-specific'. Several new concepts emphases the systemic characteristics of innovation with a focus of 'technology' (Carlsson & Stankiewicz, 1995), 'region' (Cooke, 1996; Maskell & Malmberg, 1997), 'sector' (Breschi & Malerba, 1997). However, this study does not consider these views as alternative approaches to NIS. As Lundvall (2007) pointed out, these concepts have important contributions to make general understanding of innovation in their own right. Therefore, this study considers that sectoral, regional and technological systems across nations are often an operational method for understanding the heterogeneity and dynamics of Innovation System at the national level. Therefore, 'nation' as the level of analysis is justified. Sharif (2006) presented two views on the presence of NIS in countries by interviewing advocates of the NIS concept. Based on the author, Jacobsson, Freeman and Malerba argued that Innovation System (IS) is present in all countries as they are characterised by a system of generation and diffusion of technology. However, Smith argued that NIS would switch on only when certain conditions are present based on various grounds. The author also emphasised that NIS requires specific socio-economic dimensions (or contexts) and some real structure before it gets to become useful. While the first view is very much inclined to developed economies, the second view is much suitable for emerging or emerging economies. According to Niosi (2011), the performance NIS regarding its constituents can be evaluated and improved. The NIS approach was not only an analytical concept but, also useful in building innovation systems in developing countries (Lundvall, 2007). Emerging economies are in a state to promote or build specific contexts and structure to invoke NIS for catching-up or economic purposes.

2.1.2. Evolution and Theoretical Status of National Innovation System

It is crucial to understand the theoretical status of the area of study to extend literature in that area. Therefore, this section discusses the evolution of the concept and thus the theoretical status of NIS.

2.1.2.1. Phases of Evolution of National Innovation System Literature

Many authors are involved in the evolution of NIS literature. The significant ones are highlighted below with their contribution to literature as summarised from Niosi et al. (1993, pp. 207-208), Smith, (2000) and Niosi (2011, p.1637). Three phases explain the evolution of NIS literature as discussed in the sub-topics below.

First Phase of Evolution

The first one is an embryonic phase (in between the 1930s to 1980s) during when the concept was conceptualising. This study relates the origin of the concept to technological innovation theory in the early 1930s to 1940s by Schumpeter, which was then built on with the nature of the environment such as demand and market (Schmookler, 1966) and capabilities within the firms such as Research and Development (R&D) (Freeman, 1972). It evolved as inter-firm interaction, technical alliances, collaborations and agreements (Von Hippel, 1976; Mariti & Smiley, 1983; Fusfeld & Hacklisch, 1985), user-producer interaction (Teubal, 1977), systemic nature and technical systems (Gille, 1978), Science and technology (Mowry & Rosenberg, 1979). The evolution continued with Government as an enabler through policies (Rothwell & Zegveld, 1981; Nelson, 1982) to become National Innovation System (NIS) in 1987. Freeman first used the term NIS in published form in 1987. He represented it as the 'National System of Innovation', and he defined it as 'the network of institutions in public and private sectors whose activities and interactions initiate, import, and diffuse new technologies' (Freeman, 1987, p. 1). Godin (2009) added an interesting piece of literature to the history of NIS indicating that ''system approach'' owes to the Organisation for Economic Co-operation and Development (OECD) and its very early works from the 1960s. The author added that the credit does not solely go to OECD, but also to system dynamics that existed among social scientists and system analysts in 1960s particularly in the United States at RAND Corporation (Hughes & Hughes, 2000). The RAND Corporation is a research organisation that develops solutions to public policy challenges to help make communities throughout the world safer and more secure, healthier and more prosperous. Many researchers used systems' approach to study decisions and choices regarding science, technology, and innovation (Halbert & Ackoff, 1959; Gibson, 1964; Ackoff, 1968). However, OECD is a very early and systematic user of the system approach and an influential one among Member countries in matters of policy.

Second Phase of Evolution

The second phase was between 1987 and 1990s during when the concept started gaining theoretical attention. NIS approach started gaining theoretical attention from Chris Freeman's seminal book on Japanese National Innovation System (NSI) in 1987 followed by a publication edited by Dosi, Freeman, Nelson, Silverberg and Soete (1988) that gained theoretical ground incorporating chapters by Freeman, Lundvall, and Nelson (Niosi, 2011). Based on Edquist and Hommen (2008), both Lundvall (1992) and Nelson (1993) published their major anthologies on NIS subsequently but used different approaches to their studies. Nelson's (1993) book included case studies of NIS in 15 countries and emphasised empirical case studies more than theory development. It specifies 'problems' on an empirical basis and in a pragmatic way not by referring to a formal model. Edquist and Hommen (2008) also indicated that Lundvall's (1992) book was more theoretically oriented and it followed a 'thematic' approach rather than a 'national' one. The analyses used in the book are mostly on interactive learning, user-producer interaction and innovation. During this phase, the NIS literature evolved first with user-producer interaction such as firm-university interaction or firm-research organisation interaction (Lundvall, 1985). User-producer intraction was followed by networks of institutions in public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies (Freeman, 1987). Also further evolved into the function of Government policy (Nelson, 1988), and social innovations, which relate to the way in which available resources are managed and organised both at enterprise and national level (Freeman, 1988).

Several new concepts emerged in the 1990s emphasising systemic characteristics of innovation but with a focus at different levels of the economy other than national level. They are 'technological innovation systems' (Carlsson & Stankiewicz, 1995), 'regional innovation systems' (Cooke, 1994; Niosi & Bellon, 1994; Howells, 1999; Cooke, 1996; Maskell & Malmberg, 1997) and 'sectoral innovation system' (Breschi & Malerba, 1997). Carlsson developed the concept of 'technological innovation' in Sweden. Regional Innovation System emerged and proliferated in the middle of 1990s. Malerba is well associated with 'sectoral innovation system' as the author and developed this concept with his colleagues.

Third Phase of Evolution and Current Status

The third phase is the period after the 1990s. After the 1990s, the literature on NIS increased exponentially, and the concept was adopted in several countries, where innovation policies were seen under a new systemic light (Niosi, 2011). Sectoral innovation system over national or regional innovation system or sectoral perspective of Innovation Systems (Malerba, 2002; Malerba, 2004; Malerba & Nelson, 2011) gained momentum during this phase. Interests in policy matters regarding methodology, cost and quality, complexity and path dependency, and intellectual property rules (De la Potterie, 2011; Niosi, 2011; Mowery, 2011) seen growing from both scholarly as well as policy circles. The concept is still enjoying the phase of escalating scholarly, policy and practical interests. However, it has a few competing views as highlighted in the next topic.

2.1.2.2. Alternative Approaches to NIS

Based on Godin (2009), two conceptual frameworks competed at the OECD for the attention of policymakers: National Innovation System and analysis of its components and their interrelationships, and Knowledge-Based Economy with its emphasis on production, distribution, and use of knowledge and its measurement. The authors also added that both frameworks carried, to different degrees, a system approach that emerged in the 1960s. There are also two other approaches that competed with NIS on the theoretical ground and are Porter's Industrial Clusters and Triple Helix concept. Some of the crucial ideas inherent in the innovation system concept (on vertical interaction and innovation as an interactive process) appear in Porter's industrial clusters as well as in Etzkowitz and Leydesdorff's Triple Helix concept (Etzkowitz & Leydesdorff, 2000). However, the influence of NIS is evident in innovation policy circles.

Johnson, Edquist, and Lundvall (2003) indicated that the diffusion of innovation system approach had been surprisingly fast both widely in academic circles and broad applications in policy contexts. National governments as well as international organisations such as the Organisation for Economic Cooperation and Development (OECD), the European Union, United Nations Conference on Trade and Development (UNCTAD) and United Nations Industrial Development Organisation (UNIDO), have increasingly used the approach. According to Johnson et al., (2003), four common traits make the NIS approach very attractive to policy-makers compared to other approaches and relevant to policymaking in the north as well as in the south. That is, these traits help the approach suitable for both developed as well as emerging economies. The first characteristic as discussed by Johnson et al. (2003) is NIS's focus on innovation and learning processes. The second characteristic is its adaptation of holistic and interdisciplinary perspective including all determinants of innovation involving economic, organisational, social and political factors; a whole range of different innovation involving technological, organisational and marketing innovations; and 'interdisciplinary' in the sense that it brings together perspectives from different (social science) disciplines. The third characteristic includes its application of historical and evolutionary perspectives, and the fourth one is its emphasis on interdependence and non-linearity. The authors also added that these characteristics explain the rapid diffusion of NIS approach and seem to be increasingly important in development thinking, which in turn encourages its diffusion into development theory and policy. In reality, NIS concept's accelerated spread is due to its fuzzy boundaries distinguishing academic and policy circles that allowed for cross-fertilisation by theoretical and policy considerations (Smith, 2000). In simple terms, Lundvall (2007) and Miettinen (2002) indicated that looseness and openness of NIS concept have contributed to it thriving both in academic and public policy circles. The following section looks into the foundation of NIS approach.

2.1.2.3. Foundation of NIS Approach

There are two fundamental underpinnings of NIS approach rooted in studies of innovation (Smith, 2000). They include firm-level studies on user-producer interactions in technology creation that is facilitated by industrial specialisation and common cultural and policy environments (Teubal, 1977; Andersen & Lundvall, 1987; Lundvall, 1988), and national-level policies, and social and institutional factors shaping firm behaviour (Freeman, 1987). Based on Smith (2000), the first approach was based on the evolution of specialisation and its associated patterns of interaction and learning, and the second one was based on economy-wide features of corporate behaviour, policy and support processes such as education. These differences in emphasis are noticeable in the two major studies on national systems published in the early 1990s by Lundvall (1992) and Nelson (1992) as indicated earlier in this chapter. However, this study argues that both the foundations are essential for providing macroeconomic explanations through micro-economic activities. While micro activities explaining innovation outcomes focus on firms, their macroeconomic conditions or environment, especially in national context, influence their behaviour. Smith (2000) supports this view and indicates that two themes or levels form the foundation of approaches to innovation in a systems perspective. The first one is that independent decision-making at the level of the firms does not necessarily explain innovation by firms. The second one is that environment involves broader factors shaping the behaviour of firms involving social and cultural contexts, the institutional and organisational frameworks, infrastructures, and processes that create and distribute scientific knowledge and so on. According to the author, environment mainly refers to regional or national context.

2.1.3. Summary of NIS for Policy Purposes

This section discussed the purpose of the NIS concept for the economy, the relevance of 'national' dimension, alternative approaches and evolution of the concept. After scrutinising the concept in detail, this study takes the viewpoint of Lundvall (2007) on providing 'macroeconomic explanations for economic growth through an understanding of micro-aspects' as a starting point for system promotion in emerging economies. The following section provides a theoretical foundation for NIS literature.

2.2. Theoretical Foundations of National Innovation Literature

NIS is a three-decades-old concept. However, there are a few notable authors, such as Niosi et al. (1993), Edquist and Hommen (1999), Niosi (2011), Lundvall (2007), Godin (2009), Carlsson, Jacobsson, Holmén, and Rickne (2002), Johnson et al., (2003) and Sharif (2006), have contributed in theorising the concept and identifying the fundamental perspectives of the concept. This section presents theoretical foundations of NIS from a demand-side perspective, which is relevant to the purpose of the study.

2.2.1. Innovation System and its Guiding Theories

This section starts with innovation system as a perspective of economic analysis and its guiding theories.

2.2.1.1. Perspectives of Economics Analysis

There are four different perspectives in economic analysis and are Standard neoclassical, Austrian economics, Management of innovation and Innovation systems (Lundvall, 2005). They work on the principles of allocation and innovation versus choice making and learning. Among these principles, allocation and choice making are disputed by various economists including List and Arrow as indicated by Lundvall (2005). The author also indicated that these two principles work not only on abstractions (generalisations) but make wrong abstractions. The perspective in economic analysis that works without allocation and choice making is Innovation System (IS), which works on principles of innovation and learning. Therefore, innovation and learning theories guide innovation system literature. Evolutionary theories further form the foundation for the presence of system and innovation. The sub-sections below discuss these three founding theories.

2.2.1.2. Theories of Innovation

Theories of innovation that inform Innovation Policy form one of the theoretical foundations of Innovation System. As Edquist and Hommen (1999) indicated innovation policies can be categorised as demand-side oriented or supply-side oriented and theories of innovation process as linear or systems-oriented. The authors also indicated that while linear views of innovation process support supply-side orientation in innovation policies, systems-oriented views support demand-side orientation. Linear views focus on government support regarding allocations (supply-side) to enhance effectiveness and competitiveness. Based on Gibbons et al. (1994), in a linear view of the innovation process, “science leads to technology and technology satisfies market needs”. It is rather a simple view considering the process of innovation as a smooth, unidirectional activity from basic scientific research to commercial applications without any feedback at any stage. Edquist and Hommen (1999) argued that this as an unrealistic view. However, this view is in line with neo-classical economic theory’s “market failure” explanations of the need for government support of industrial R&D, both directly (through subsidies) and indirectly (through funding of basic scientific research) (Arrow, 1962; Nelson, 1959). Edquist (1994) argued that this view not be practically helpful, as it does not provide insights for government intervention regarding the amount of government intervention required, the particular fields in which it is required, or the type of intervention required. However, views of systems perspectives on innovation considered fruitful both for theoretical and policy relevance as they inform governments on interventions required from the demand-side through policies to enhance the innovation performance. This study focuses on the constituents of NIS for system promotion with an understanding of micro-aspects for macroeconomic decisions through policies in emerging economies. Therefore, this study is demand-oriented and is founded on systems approaches to innovation.

2.2.1.3. Theories of Learning

Theories of learning also form the basis for innovation system literature. Based on Edquist and Hommen (1999), analysis of innovation systems is based on a combination of innovation and learning. The effect of ongoing activities can also result in innovation on demand-side or firm level. Understanding how ongoing activities may result in innovation is learning and is critical for innovation system (Lundvall, 2007). Therefore, innovation processes result in both innovation and knowledge or competence building through learning. This competence or capability (knowledge) results in further innovation. Therefore, in an innovation system, knowledge is one of the most critical resources (capability), and learning is one of the essential processes. Learning-related theories are mainly based on learning by doing, using and interaction (Lundvall, 2005). Edquist and Hommen (1999) highlighted that new capabilities emerge while old ones are destroyed (creative destruction of Schumpeter) during the process of learning, which is critical for innovation. During the time, the system also evolves in the process of creative destruction of both knowledge and relationships. Patterns of collaboration and communication aid learning process and shape innovation systems towards innovation outcomes. Therefore, interactive learning theories played a critical role and considered as one of the crucial foundations of NIS in this study.

2.2.1.4. Evolutionary Theories

Evolutionary theory is one of the theoretical perspectives that have strongly influenced the development of innovation system. Evolutionary theories highlight some essential properties of systems. They include features, such as irreversibility, specificity, path dependency, and multi-stability (Niosi et al., 1993). Niosi et al., (1993, pp.217-8) explain these characteristics as follows. First, the order and complexity of a system after transition can be more significant than before and referred as specificity. Secondly, the number of states after transition can be 44rgreater than that before transition and referred as multi-stability. Thirdly, in proximity to a transition, a system undergoes stochastic fluctuations, and its behaviour becomes indeterminate, which is called path dependency, the outcome of a transition depends on the path followed to reach the final state. Fourthly, the transition of systems is irreversible, in the sense that it is not possible to return to a previous state of the system without introducing some change in the external environment. Due to these evolutionary characteristics of a system, growth is not a smooth process but somewhat discontinuous over time, involving a struggle between new and old combinations or blocks in the economy, which is a struggle that intensifies in periods of creative destruction (Enflo, Kander, & Schön, 2008). These features relate to development block approach. As the NIS considered for the study is required to evolve for catch-up, development block approach provides the foundation for promoting NIS.

This section briefly explained the three founding theories of innovation system and indicated specific aspects of them that guide demand-oriented NIS. The supply-oriented system provides infrastructure and institution at the national level to facilitate innovation. It is up to the ability of the firms to take advantage. Firms in developed economies can use the supply support to realise innovation. Based on Pattinson et al., (2015), demand-oriented system shapes the context within which firms operate to realise innovation. Firms in emerging economies are not able to exploit mere supply push to facilitate innovation. Instead, they require measures to stimulate demand for innovation, intelligent and pre-commercial procurement policies, innovation inducement prizes and standardisation and regulation. Public policies created with this understanding could influence innovation in firms. This demand-oriented view promotes or builds a system for innovation outcomes.

2.2.2. Theories Related to Dimensions of National Innovation System

The specific approaches or theories that guided the study to unravel dimensions of demand-oriented NIS or NIS for system promotion are systemic approaches to innovation (from theories of innovation), Interactive learning theories (from theories of learning), and developmental block approach (from evolutionary theories).

2.2.2.1. Systems Approach to Innovation

The systems approach to innovation is a specific area of innovation studies that guides NIS for system promotion. According to Smith (2000), `Systems' approaches to innovation is explained by one of the most persistent themes in modern innovation studies that focuses on firms. Further, independent decision-making at the level of firms does not necessarily explain innovation by firms. This view of innovation considers innovation process as an intricate interplay between micro and macro phenomena where macro-structures condition micro-dynamics and vice versa new macro-structures are shaped by micro-processes (Lundvall, 2007). A "system' can be referred to a few simple ideas, the system as a whole is more than the sum of its parts, and potentially complicated interrelationships and multiple kinds of interactions between elements are as crucial for processes and outcomes as are elements (Lundvall, 2007; Edquist & Hommen, 1999). Based on Smith (2000), innovation involves complex interactions between a firm and its environment. The primary argument of systems theories is that system conditions have a decisive impact on the extent firms can make innovation decisions and on modes of innovation. This view has practical relevance for innovation policies in demand-oriented contexts.

The discussions of Lundvall (2007) and Smith (2000) contribute to two major constituents of NIS regarding micro phenomena or firms and macro phenomena or environment. Both authors indicate clearly that geographical orientation of environment specific to region or nation is dynamic too due to changes in political conditions, technological evolution and associated new opportunities, economic integration processes and so on. Smith (2000) further elaborated on constituents of environment that shape behaviour of firms as social and cultural contexts, institutional and organisational frameworks, infrastructures, knowledge infrastructure and knowledge flow and so on. The discussions related to firms are mainly on overall firm attributes regarding decision-making, activities and choice of modes of innovation.

2.2.2.2. Interactive Learning Theories

Nielsen (1991) informs, and Lundvall (1992) supports the analytical focus on interactive learning theory for innovation system. Based on Nielsen (1991), mainstream economic theory concentrates its attention on issues of responsiveness to price signals but neglects analysis of innovation as a process guided by responses to other signals as well as responses transmitted in other forms of social interaction than market exchange. Lundvall (1992) added to this argument indicating innovation process as interactive, and this notion of interaction leads to systemic approach and thus innovation system. His analytical approach stresses on processes of learning (for capability or competency building) and user-producer interaction. Authors within 'interactive learning' tradition draw attention to how innovation processes, like most learning processes, are influenced by the institutional set-up of the economy (Johnson, 1992). Interactive learning theory also places more importance on the quality of demand compared to demand as a quantity (Lundvall, 1988). Interactive learning theory considers 'lack of competence by users' 'domination of innovation' to be as serious a problem as lack of competence on the producer side (Lundvall, 1988), which is referred as 'lack of demand articulation'. Lundvall (1988) brought learning in organised markets into clearer focus through interactive learning theories. The theory expects markets, where products are complex and changing rapidly, to have high requirements for direct cooperation and exchange of qualitative information, leading users and producers to establish specific channels and codes of information (Edquist & Hommen, 1999). At the same time, Lundvall (1988) also highlighted major concern of interactive learning theory as established 'knowledge structures'. According to the author, these knowledge structures formerly necessary for innovation could later become sources of inertia and resistance to change.

The views of Lundvall (1992) and Johnson (1992) demonstrate a broad approach relating two broad dimensions of NIS 'national context' and 'firms' through interactive learning. While Johnson's focus was on 'institutions' (Johnson, 1992) in the national context, Lundvall focuses on constituents such as markets (Lundvall, 1992; Edquist & Hommen, 1999) and 'knowledge infrastructure' (Lundvall, 1988). Regarding firms, Lundvall's discussion captures 'capability' regarding learning, 'interactions' and 'demand articulation' (which is a transformative attribute of a firm for growth or evolution).

2.2.2.3. Development Block Approach

A system-oriented theme on 'development blocks' that focuses on the demand side regarding firms is the Schumpeterian concept of "collective entrepreneur", which is introduced as an essential condition for successful innovation processes (Edquist & Hommen, 1999). Based on these authors, an entrepreneur, which is often a firm, requires transformational attributes to innovate in a case of sophisticated technologies that demand extensive resource mobilisation. These attributes indicate that a firm should have a vision based on perceptions or needs for the future, identify requirements, secure resources required and articulate and align with relevant agents. Based on Carlsson et al. (2002, p.235-6), 'when an innovation creates new opportunities, these opportunities may not be realised (converted into economic activity) until pre-requisite inputs (resources and skills) and product markets are in place. Each innovation, therefore, gives rise to a 'structural tension', which when resolved, makes possible progress and may create new tensions and which, if unresolved, may bring the process to a halt'. Carlsson et al. (2002) and Edquist and Hommen (1999) also noted that 'Swedish economic historian Erik Dahmen pioneered development blocks' approach to work first published in 1950. This approach was later elaborated by others such as Freeman (1991) and Edquist and Lundvall (1993). Dahmen (1988), the pioneer of this approach, indicate that development block theory specifically emphasises needs for linkage and coordination arise out of structural economic tensions emanating from gaps in technological development. Price and cost signals and other forms of communication among actors in economic networks are the indications of these tensions. According to Edquist and Hommen (1999), a 'development block' is a large-scale framework for interactive learning. This approach enables policymakers to understand transformational attributes of firms. This understanding helps firms to stabilise the situation and look for new opportunities. However, governmental intervention is required when there are sophisticated technologies and requirement of massive resources.

From discussions based on Edquist and Hommen (1999), 'transformational attributes' form one of the important dimensions of NIS within firms. Dahmen (1988), Edquist and Lundvall (1993) and Edquist and Hommen (1999) highlighted the importance of 'interaction' dimension for firms. The discussion of Carlsson et al. (2002) on development approach contribute to the idea that 'capabilities' (resources and skills) of firms and 'markets' in the national context constitute demand-oriented NIS. Figure 2.1 presents a summary of the theoretical foundations and dimensions of NIS.

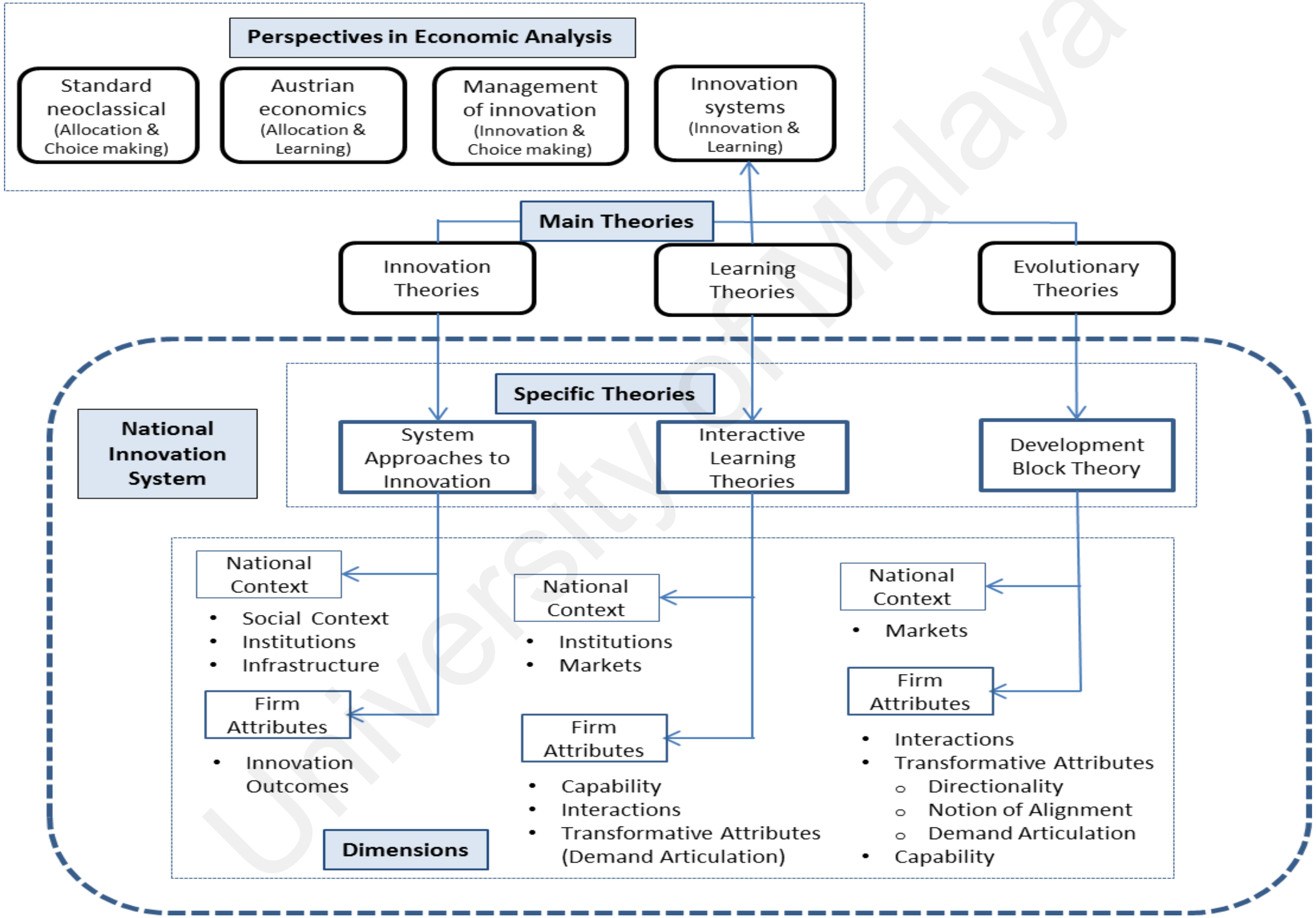

Figure 2.1: Summary of Theoretical Foundations and Dimensions of National Innovation System

2.2.3. Summary of Theoretical Foundations

NIS is founded on one of the perspectives of economic analysis 'innovation system', which is guided by innovation, learning and evolutionary theories. As this study focuses on demand-oriented NIS for system promotion, demand-oriented approaches of these main theories form the foundations of NIS for this study and are systems approach to innovation, interactive learning theories and development block approach. These approaches explain dimensions of NIS. The following topic covers 'innovation outcomes', which is expected to be the outcome of NISs.

2.3. Innovation Outcomes

The expected effect of NIS is innovation outcomes. According to Sun and Grimes (2016, pg.18), "Innovation is a crucial factor for competing with other states and for explaining differences in levels of growth between countries, although explaining differences in levels of innovation between countries is challenging". Chapter 1 defined innovation. Different types of innovation include social, organisational, administrative or technical, incremental or fundamental, product or process (Jost, Lorenz & Mischke, 2005). The performance of innovation system is measured either directly or indirectly (Niosi et al., 1993). The direct measures of innovation include patents, copyrights, trademarks, industrial designs and so on. The indirect measures are related to economic or industrial performance such as sales share of new or improved products, productivity, reduced cost, and so on (Hollenstein, 2003; Tether & Tajar, 2008). According to Niosi et al. (1993), empirical studies on NISs have also used an array of indicators including characteristics of elements (number, size, type of ownership, regional distribution and degree of centralization of innovation units) and the flows (technological, financial, social, commercial, and legal or political) to assess performance of systems. However, based on Mangiarotti and Riillo (2014), the traditional innovation matrices (e.g. product and process) may not be sufficient to capture the complexity of innovation. The discussion on the complexity is true for services sector where production and consumption are simultaneous (Gallouj & Savona, 2009). A review of measures of innovation from MASTIC (2014, p.4) indicated that 'the traditional measure of innovation was either input based (R&D indicators, which was introduced in the 1930s) or output based (patent-based indicators or commercialisation of innovation, which was introduced in 1950s)'. The focus from input or output indicators shifted to subjective measures in the late 1970s. Meyer-Krahmer (1984) and Archibugi, Cesaratto and Sirilli (1987) indicated that these measures considered innovation as an activity and collected a range of data via firm-based surveys. 'Innovation activities are all scientific, technological, organisational, financial and commercial steps which actually, or are intended to, lead to the implementation of innovations. Some innovation activities are themselves innovative; others are not novel activities but are necessary for the implementation of innovations. Innovation activities also include R&D that is not directly related to the development of a specific innovation' (OECD & Eurostat, 2005, p.47). Therefore, since the first publication of the Oslo Manual in 1992, 'activity approach' is the official and preferred method for measuring innovation at the national level.

Oslo manual on 'Guidelines for Collecting and Interpreting Innovation Data' stipulated that 'the minimum requirement for innovation is that the product, process, marketing method or organisational method must be new (or significantly improved) to the firm. These innovations include products, processes and methods that firms are the first to develop and those adopted from other firms or organisations' (OECD & Eurostat, 2005, p.46). The report also highlighted that this narrow definition using minimum requirements is useful regarding policy and research purposes for comparing sectors and firms of different sizes. Following minimum requirement of innovation advocated by the Oslo's manual, this study argues that types of innovations realised by firms in a particular term could be an indicator of 'innovation outcomes'. The reason is all types of innovations have direct or indirect economic benefit. Some of the innovations are quantifiable and some or not. While the benefits of some innovations are realised immediately, others take time, but they do bring benefit. Therefore, what is important to measure is whether a particular firm realised an innovation or innovations in any form or not. The four types of innovations (product innovation, process innovation, marketing innovation and organisational innovation) listed by Oslo's manual as a minimum requirement would be a proper measurement of innovation outcomes. Table 2.1 presents brief descriptions of the four types of innovations.

Table 2.1: Types of Innovation

Type of Innovation	Description
Product Innovation	The introduction of a good or service that is new or significantly improved concerning its characteristics or intended uses. Significant improvements in technical specifications, components and materials, incorporated software, user-friendliness or other functional characteristics are included. Product innovations can utilise new knowledge or technologies, or be new uses or combinations of existing knowledge or technologies.
Process Innovation	It is the implementation of a new or significantly improved production or delivery method. Significant changes in techniques, equipment and software are included. Process innovations aim to decrease unit costs of production or delivery, to increase quality, or to produce or deliver new or significantly improved products.
Marketing Innovation	It is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.

Type of Innovation	Description
	'Table 2.1, continued'.
	Marketing innovations focus on better addressing customer needs, opening up new markets, or newly positioning a firm's product on the market, with the objective of increasing the firm's sales.
Organizational Innovation	It is the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations. Organizational innovations can be intended to increase a firm's performance by reducing administrative costs or transaction costs, improving workplace satisfaction (and thus labour productivity), gaining access to non-tradable assets (such as non-codified external knowledge) or reducing costs of supplies.

Source: OECD and Eurostat (2005, pp.47-52)

This section discusses the expected outcome of NIS with an indication that different types of innovation realised in firms could be a measure of innovation outcomes. The following section discusses dimensions of NIS in detail that lead to innovation outcomes.

2.4. Dimensions of National Innovation System

Consideration of a system as a whole is vital to discuss dimensions of NIS. Referring to the system studies perspective, Carlsson et al. (2002) indicate that a system as a whole consists of components (operating parts of a system), relationships (links between components) and attributes (properties of the components). The same view on the constituents of a system is also highlighted by Edquist and Hommen (2008). For a discussion of dimensions from the viewpoint of system construction, this study considers perspectives of Carlsson et al. (2002) and Edquist and Hommen (2008). Based on the authors, a 'system' has three distinct features and are two types of constituents regarding components and relations among them, functional feature to perform or achieve something, and the third feature is the ability to discriminate between the system and the rest of the world (identify the boundaries). Edquist and Hommen (2008) indicate that constituents regarding components and relations form a coherent whole, with properties different from those of the constituents. Considering the National Innovation System, it sets out to enhance innovation outcomes for economic benefit, and 'nation' sets a prominent boundary to distinguish it from the environment.

Weber and Rohracher (2012) conceptually discuss the idea of innovation system as a multidimensional concept for identifying systemic issues. Three major dimensions constitute the innovation system. They are structural dimension (Lundvall, 1992; Nelson, 1993; OECD, 1997; Smith, 1997; Lankhuizen & Woolthuis, 2003; Woolthuis, Lankhuizen, & Gilsing, 2005; Wieczorek & Hekkert, 2012), market dimension (Sharif, 2006; Klerkx, van Mierlo, & Leeuwis, 2012), and transition or transformation dimension (Smith, 2000; Klerkx et al, 2012). These three dimensions have further sub-dimensions. However, these authors have not established and explained interrelationships among these dimensions empirically. The qualitative explanations showed great variations in conceiving the concepts and compositions. Wieczorek and Hekkert (2012) indicated that a great diversity of perspectives on the concept and composition of innovation systems is quite challenging for practical applications or designing a framework for the analysis of systems, identification of problems and design of policies. Therefore, studies of these sorts challenged policy implications. This study argues that NIS needs to consider two broad constituents' namely national context and firms to enable effective and efficient policy formulation and implementation for system promotion. This argument is in line with discussions of

Smith (2000), Lundvall (2007) and Patana, Pihlajamaa, Polvinen, Carleton, and Kanto (2013). These studies further consider firms as the core of the NIS concept within the national environment, which is dynamic and has an influence on firms' activities and thus their performance. However, firms alone cannot produce innovation; they have to work as a part of the system to learn and innovate. The system involves firms (their characteristics) and their contexts (institutions, markets & infrastructure). As discussed in the previous paragraph, a system should have a boundary. Therefore, 'nation' is treated as the boundary here. The argument here is that components of NIS and relationships among them vary among nations and different combinations of them result in different innovation outcomes. It is critical to understand whether the activities of firms to realise innovation seem to show traces or patterns of NIS (firms and their contexts) or not. This understanding of components of NIS and relationships among them are essential for policy planning and implementation. The components of NIS are referred as dimensions, elements and measures in scholarly discussions. This section focuses on main constituents (firms and their contexts) and dimensions of NIS within them.

2.4.1. Firm as Constituent of NIS

Firms are the core or key actors of Innovation Systems. The argument to focus NIS on firms and their involvement with others is based on Lundvall (2007), Whitley (2007), Weber and Rohracher (2012), Nelson and Rosenberg (1993) and Meuer, Rupietta and Backes-gellner (2015). Based on these authors, firms are units that play the most important role in innovation system and that matters for innovation. Because firms are units where innovation is realised and applied for the economic benefit, which eventually benefits the nation. Based on an empirical study carried out by Leiponen and Drejer (2007) using firm-level survey data from Finland and Denmark, patterns of innovation within and across industries are not at all uniform regarding how firms innovate, and in almost all industries three or more different modes of innovation can be identified. These patterns indicate that firms are not homogenous even within a particular industry. It is evident that firms are heterogeneous in their innovation behaviour (Christensen, 2002; Massini, Lewin & Greve, 2005). However, understanding of this heterogeneity in NIS remains unclear.

Based on the discussions above, 'firm' is one of the major broad constituents of NIS. Three dimensions can be noted within 'firms' and are 'capability' (of firms),'interactions' (with other firms, public institutions, suppliers, competitors and so on), and 'transformational attributes' (ability to align, adapt and articulate demand). Firms often lack in their capability, interaction (networking) and transformative (transitional) attributes to be innovative in emerging economies. The following subtopics discuss the dimensions: capability, interaction and transformational or transition attributes within firms.

2.4.1.1. Capability

Definition and Description

There are several descriptions of this dimension in the scholarly discussion, and it is referred as 'competence and resources' (Weber & Rohracher, 2012) and 'authority sharing' (Whitley, 2007). Carlsson et al. (2002) discuss that to understand functions of a system (regarding production, distribution and use of innovation), it is important to study capabilities of actors, which is critical to influence innovation and carry economic value.

The function of an innovation system is to generate, diffuse, and utilise technology or knowledge. Thus, the main features of a system are capabilities (together representing economic competence) of actors to generate, diffuse, and utilise technologies (physical artefacts as well as technical know-how) that have economic value. Economic (or techno-economic) competence is the ability to identify and exploit business opportunities (Carlsson & Eliasson, 1994). Capability dimension is referred as a system's ability to ensure timely access to the relevant stocks of knowledge by firms (Smith, 2000). Also access new knowledge using appropriate competencies and resources to enable firms to adapt to changing circumstances, to open up novel opportunities, and to switch from an old to a new technological trajectory (Weber & Rohracher, 2012). It is also further referred as the technical and organisational capacity to adapt and manage new technologies and organisational innovations such as a certain level of entrepreneurship, adequately educated persons, time to dedicate to innovation, and networking skills (Klerkx et al., 2012). The capability is also ‘‘capacity to learn, innovate or utilise available resources, identify and articulate their needs, and to develop visions and strategies'' (Wieczorek & Hekkert, 2012, p. 79). Whitley (2007) refers capability of firms in innovation development as 'authority sharing'. ‘Authority sharing’ refers to the extent to which managers (as well as owners) learn from various groups of employees, business partners and other organisations within and beyond their industry, and develop organisation specific routines for integrating new knowledge from these groups. This form of authority sharing engages employees in problem-solving activities by actively incorporating their knowledge with business partners' as well as other external organisations. The author refers this as 'authority sharing' by the author because it implies a willingness to delegate authority over and actively encourage involvement in innovation development and problem-solving activities. Based on Chaminade, Intarakumnerd, and Sapprasert (2012), firms ability to absorb knowledge generated by other organisations in the system is the 'capability'. This study considers that in an emerging economy, firms require having all relevant resources for innovation. Therefore, this study refers ability of firms to acquire relevant resources internally or externally and utilise them for innovation as the capability of the firm. As some authors mentioned, firms' ability to articulate demand and project future is crucial, and discussed under 'transformative attributes'.

Smith (2000) indicated that what determines performance within the complex structure of differentiated knowledge is not so much knowledge creation, but `distribution power' of a system. This 'distribution power' is the system's capability to ensure timely access by innovators to relevant stocks of knowledge. Whitley (2007) argues that these characteristics of firms towards the development of new products, processes and services constitute a major differentiating characteristic of innovation systems in market economies. Firms may lack competencies, capacity or resources, which may prevent their innovation performance. Therefore, individual strength or capability of a firm is critical, and an understanding of what firms think important as a capability and its influence on firms become critical. The section below discusses the measurements of firms' capability to achieve innovation.

Measurements of Capability

Carlsson et al. (2002), Padmore, Schuetze, and Gibson (1998) and Chaminade et al. (2012) attempt to provide some indicators of firm capability when it concerns Innovation Systems. Carlsson et al. (2002) indicate four types of abilities of firms' namely selective or strategic ability, organisational (integrative or coordinating) ability, functional ability, and learning (or adaptive) ability. Based on the authors (p.235), the abilities are described briefly as 'strategic capability is the ability to make innovative choices of markets, products, technologies, and organisational structure, engage in entrepreneurial activity, and select key personnel and acquire key resources, including new competence. Organizational (integrative or coordinating) ability is the main function of middle management in an organisation to organise and coordinate resources and economic activities within an organisation to achieve the overall objectives. Functional ability involves efficient execution of various functions within a system to implement technologies and utilise them effectively in the market. Learning (or adaptive) ability is the ability to learn from success as well as failure, identify and correct mistakes, read and interpret market signals and take appropriate actions, and diffuse technology throughout a system. The authors also indicate that these abilities produce economic value. Padmore et al. (1998) view firms' capability regarding their knowledge embodied in goods and services, acquisition of intellectual property, and acquisition of human capital. However, Chaminade et al. (2012) categorised capability of firms regarding 'scientific and technological capabilities' and 'complementarity or diversity of capabilities'. Based on the definition of capability used for the study, the measurements proposed by Padmore et al. (1998) are suitable.

2.4.1.2. Interaction

Definition and Description

In addition to firms' capabilities with which they function, firms and other actors need to be a part of formal and informal networks to engage in innovation activities for national benefit. Lankhuizen and Woolthuis (2003) indicated that Interaction is central to the process of innovation, that is, the interaction between actors (firms, universities, intermediaries and so on) within the framework of existing institutional rules (laws, norms, and technical standards). Central to the concept of interaction is both cooperation and interactive learning (Lundvall, 1992). Guided by this argument, this study considers that interactions not only involve relationships with other firms, but also involve interactions with others, for example, government, universities, and third parties such as specialised consultants.

Scholarly discussions in NIS consider interaction as one of the crucial structural element of NIS, hence a central element to the analysis of NIS. Scholarly discussions also use other terminologies such as 'networks' (Carlsson & Jacobsson, 1997; Woolthuis et al., 2005), 'links', 'corporate relationships', 'knowledge flows' and 'authoritative coordination' (Whitley, 2007) to represent interaction dimension of NIS. Interaction in NIS refers to innovation activities coordinated through market transactions or more continuous and cooperative relationships with economic actors governed by common authority commitments (Whitley, 2007). Interactions (knowledge flows) also involve involvement with Public Science systems (Whitley, 2007). Smith (1999, p. 21) refers relationships that "persist through time and involve inter-firm cooperation in the development and design of products" as market relationships.

There are also discussions of types of interactions. Carlsson and Jacobsson (1997) distinguished between a weak and strong network that arise in situations in which interaction is too weak (little or no interaction) or too strong (too much interaction). Malerba and Orsenigo (1997) refer to situations of weak network failure as dynamic complementarities failure. Both strong and weak network can hamper innovation (Woolthuis et al., 2005). Strong network refers to intensive cooperation between actors. Based on Rothwell (1989, 1992), Contractor, and Lorange (1988), a strong network can be very productive as a source of synergy, complementary expertise, creative problem solving, capacity sharing and so forth, but this implies risk too. The risk as described by Carlsson and Jacobsson (1997) is, other network actors guide individual actors in the 'wrong direction' and consequently fail to supply each other with required knowledge. Close relationship prevents firms from getting access to external and new knowledge and challenging existing knowledge, routines and so on. Close network potentially blocks renewal from outside, which will influence innovation outcomes. However, complementarity regarding knowledge, skills, expertise and capacity among actors is critical to firms for innovation to take place. When the connectivity among these actors of NIS is weak, it affects fruitful cycles of learning and innovation. Carlsson and Jacobsson (1997) refer to this as a weak network, which is consistent with the concept of dynamic complementarity problem (Malerba & Orsenigo, 1997). Because of the weak network, possibilities for interactive learning and innovation are underutilised, and firms may fail to adapt to new technological developments. Carlsson and Jacobson (1997) also indicated that weak network might lead to a lack of shared vision of future technology developments, which in turn might hinder coordination of research efforts and investment.

From the discussions, it is clear that both strong and weak networks may enhance or hinder successful innovation and an understanding of networks or interaction is critical for the analysis of NIS. Wieczorek and Hekkert (2012) indicated that ‘interaction’ is dynamic and it is difficult to consider it as a structural element. Therefore 'network' has been used in literature positions (Jacobsson & Johnson, 2000) to describe cooperative relationships and links between actors, but a 'network' can also be seen as a higher form of actors' organisation. This study is aware that interactions are not restricted to occurring within networks. The focus here is on relationships, and they can be analysed at the level of networks regarding characteristics, existence or importance to firms.

Measurements of Interaction

Interactions not only involve relationships with other firms, but they also involve interactions with others such as government, universities, and third parties such as specialised consultants (Lankhuizen & Woolthuis, 2003; Woolthuis et al., 2005). Innovation goals are also achieved through other inter-firm alliances, alliances with other business groups (such as suppliers, customers), research consortia and commercial labs. Based on the authors above, the interaction can be measured through inter-firm alliances, interaction with government, universities, interaction with third parties such as specialised consultants, alliances with other business groups (such as suppliers, customers), and research consortia and commercial labs.

Based on Wieczorek and Hekkert (2012), the interaction can be measured at the level of networks and individual contacts. Carlsson and Jacobsson (1997) highlighted that strong or weak network could measure the level of the network. Whitley (2007) argues that firms' involvement in public sciences and authoritative coordination are forms of interactions for knowledge flows. He refers to universities and other public research organisations as public sciences. The author discusses that firms could form three possible interactions with public sciences namely passive and indirect form mainly for training purposes, direct, active and formal engagement to support firms' technologically focused research activities, and higher levels of active involvement through close links for general processes and phenomena. Based on the description of interaction considered for the study, the measurements of interaction by Lankhuizen and Woolthuis (2003) and Woolthuis et al., (2005) are suitable here.

2.4.1.3. Transformational Attributes

Definition and Description

Smith (1999) and Edquist et al. (1998) discuss transformational elements as transition failures and lock-in/ path dependency failure. Transition failure being the inability of firms to adapt to new technological developments and lock-in/path dependency failures being the inability of complete (social) systems to adapt to new technological paradigms (Smith, 1999). Edquist et al. (1998) address the same failure but do not distinguish so strictly between transition and lock-in failure (Lankhuizen & Woolthuis, 2003; Woolthuis et al., 2005). Smith (1999) explains transition failure as; firms usually focus on products and technologies that they are familiar with regarding experience and skills. While this focus enables firms to do their things right, it can severely obstruct their development if capabilities required to adapt to new technologies lie outside firms' existing capabilities. Malerba and Orsenigo (1997) discuss the same phenomenon under the heading of 'learning failure'. If firms or industries do not learn rapidly and efficiently, they might lock-in into existing (technological) trajectories. Transition or transformative change refers to the question of direction and requires the setting of collective priorities, priorities that require a strategic policy approach to be in place (Weber & Rohracher, 2012).

Although transformation dynamics are not of central concern for innovation systems research, Weber and Rohracher (2012) insisted that policy prescriptions should look into dynamics of socio-technical change and attempt to link and support such dynamic growth processes to structural components, such as institutions, networks, firms and other actors. Transformational attributes of firms are described as technical and organisational characteristics to adapt to and manage new technology and organisational innovations, such as certain level of entrepreneurship, adequately educated persons, time to dedicate for innovation initiatives, and networking skills (Klerkx et al., 2012). Wieczorek and Hekkert (2012. p.79) include this attribute as a part of the definition of firm capability as, 'capacity to learn, innovate or utilise available resources, to identify and articulate their needs, and to develop visions and strategies'. Weber and Rohracher (2012) insist integration of innovation systems and transition approach to take place at an analytic level of micro and macro-level system dynamics. They believe that devising coherent policies require 'unification' of these approaches. There are several terminologies, such as transformational, transitional, learning, lock-in and path-dependency, in scholarly discussions to represent transformational attributes. However, this study uses terminologies transformative and transitional attributes interchangeably. This study further describes this attribute at the micro level as firms' ability to identify and articulate demands and plan for future in alignment regarding visions and strategies.

Transformative attributes are essential for firms in emerging economies to leap forward. Based on Woolthuis et al. (2005), firms can leap from an old to new technology or paradigm and be innovative only when they have capabilities such as flexibility, learning potential, and resources to adapt to new technologies and market demands. Four distinct transformational attributes identified in the literature are directionality, demand articulation, policy coordination and reflexivity. These attributes are not extensively discussed in literature except Weber and Rohracher (2012) and Klerkx et al. (2012). Based on the authors, the following paragraph briefly describes these attributes.

Directionality refers to the contribution to a particular direction of transformative change in addition to the necessity to generate innovations as effectively and efficiently as possible (Weber & Rohracher, 2012). Based on the authors, this direction is, by identification of major societal problems or challenges, for which research and innovation develop solutions. Directionality requires collective priorities and priorities that require a strategic policy approach to be in place. Demand articulation is the ability regarding anticipating and learning about user needs. Based on Klerkx et al. (2012), demand articulation refers to the articulation of innovation needs and visions and resultant demands regarding technology, knowledge, funding and policy, achieved through problem diagnosis and foresight exercises. From an innovation systems perspective, the importance of ‘‘an organised articulation of demand’’ particularly within new or fragmented market settings is highlighted by Edquist and Hommen (1999). Geels (2004) stresses the importance of users within a ‘‘socio-technical’’ conception of innovation systems. Sumberg (2005) focuses on users and considers demand as an economic agent as being ‘‘in the market’’ for innovations. The author also indicates that this will increase firms’ efficiency, provide a competitive edge and so forth. Such a view of users is in-line with widely accepted notion that ability to articulate demand can be a source of innovation. Based on Weber and Rohracher (2012), enabling uptake of innovations by users and consumers via policy interventions refers to demand articulation. Weber and Rohracher (2012) describe the ‘notion of coordination’ as an interaction of different levels and areas of policies relevant to transformative change, which refers to ‘policy coordination’. The authors also indicate that ‘notion of coordination’ is not an issue at the policy level, but it is the coordination at the actors’ level. For example, the notion of coordination failure in research and innovation policy refers only to coordination problems of R&D actors. Therefore, the policies meant for coordination are to encourage collaborations, interactions and interchanges at the actors’ level for innovation outcomes. It is important for the policy to have an impact at the actors’ level and thus coordination between both levels becomes critical. Reflexivity refers to reflecting on the relationships between key items, the long-term goals of an innovation endeavour, normalised practices, and developments in systems surrounding them that offer not only barriers but also opportunities for innovation (Klerkx et al., 2012). Reflexivity addresses the ability of innovation system to monitor, anticipate and involve actors in processes of self-governance. It is the process of reflection on the performance and exploration of the reality of the environment to firm's advantage. The following sub-section discusses the measurements of transformative attributes.

Measurements of Transformative Attributes

Measurements for transformative attributes are not available in the extant literature. However, Weber and Rohracher (2012) have attempted to outline some measures for these attributes. Table 2.2 presents measures of transformative attributes.

Table 2.2: Measures of Transformational Attributes

Transformational Attributes	Measurements
Directionality	• Having shared vision regarding goal and direction of transformation process; • The ability of collective coordination of distributed agents involved in shaping systemic change; • Sufficient regulation or standards to guide and consolidate direction of change; • Targeted funding for research, development and demonstration projects and infrastructures to establish corridors of acceptable development paths.
Demand Articulation	• Sufficient spaces for anticipating and learning about user needs to enable uptake of innovations by users; • Having provisions for orienting and stimulating signals from public demand; • Demand-articulating competencies.
The Notion of Coordination	• Multi-level policy coordination across different systemic levels (e.g. regional–national or between technological and sectoral systems);

Transformational Attributes	Measurements
'Table 2.2, continued'.	
	• Horizontal coordination between research, technology and innovation policies on the one hand and sectoral policies (e.g. transport, energy, agriculture) on the other; • Vertical coordination between ministries and implementing agencies (coordination between strategic intentions and operational implementation of policies); • Having coherence between public policies and private sector institutions; • Timely interventions of different actors as a result of temporal coordination.
Reflexivity	• The ability of the system to monitor, anticipate and involve actors in processes of self-governance; • Distributed reflexive arrangements to connect different discursive spheres, provide spaces for experimentation and learning; • Adaptive policy portfolios to keep options open and deal with uncertainty.

Source: Weber and Rohracher (2012)

This section covered one of the constituents of NIS 'firm attributes' and its dimensions. The following section discusses 'national context' as a constituent of NIS.

2.4.2. National Context as Constituent of NIS

Freeman (1982) called for an active role of government policy and presented that as a legitimate necessity for catching-up economies. National environment or context influences firms' core activities (OECD, 1999; Smith, 2000; Whitley, 2007; Weber & Rohracher, 2012) and innovation outcomes (OECD, 1999). Thus, 'national context' becomes one of the constituents of NIS. Smith (2000) indicated that two themes or levels form the foundation of approaches to innovation in a systems perspective. The first theme highlights that independent decision-making at the level of the firm does not solely explain innovation by firms. The second one indicates that environment involves broader factors shaping the behaviour of firms. Smith (2000) further elaborated on constituents of the environment as social and perhaps cultural context, institutional and organisational framework, infrastructures, knowledge infrastructure, and knowledge flow. Chapter 1 covers the environment, national context, and its relevance and justification for this study. Manipulation of social or cultural contexts requires more than policy initiatives. Therefore, this study considers institutions, infrastructure (includes knowledge infrastructure) and markets as constituents of national context for policy purposes. The sub-section below covers the three dimensions of national context.

2.4.2.1. Institution

Definition and Description

In general, the definition of 'institution' includes rules of a game, organisations and their entrepreneurs as players (North, 1990). In an attempt to study the role of institutions on learning and innovation, Rasiah (2011a, p.165) commented that 'institutions refer to influences that govern human action either individually or collectively (through a firm, organisation or a particular group) and are considered by many as the sine qua non of economic development'. Therefore, evolutionary economists have preferred to keep its meaning to capture whatever that holds and moulds standard behavioural patterns in society'. Further, institutions reduce uncertainty in an economic system and form a critical factor in systems theory that envisages institutional context as a defining and structuring element in the system (Lankhuizen & Woolthuis, 2003). Based on these authors, institutions are conceptualised as selection environment, which comprises of firms, knowledge institutes as well as government.

Institutional dimension involves political, financial, labour and market institutions (Whitley, 2007). Whereas Carlsson and Jacobsson (1997) refer to hard- and soft institutions, Edquist et al. (1998) refer to consciously created versus spontaneously evolved institutions. Johnson and Gregersen (1994) distinguish between formal and informal institutions. Although differently named, there is a clear consensus that there are 'hard' institutions, being formal, written, consciously created institutions, and 'soft' institutions, which are informal, have often evolved spontaneously and may be the implicit 'rules of the game' (North, 1990). Soft and hard institutions are further explained as institutions encompassing a set of common habits, routines and shared concepts used by humans in repetitive situations as soft institutions and organised by rules, norms and strategies as hard institutions (Crawford & Ostrom 1995; Wieczorek & Hekkert, 2012). Both may regulate economic behaviour and interaction and can thereby stimulate or hinder innovation (Woolthuis et al., 2005).

Lankhuizen and Woolthuis (2003) added to the discussion that these hard institutions regarding laws and regulations are often at the national level. They also include legal system relating to contracts and employment, intellectual property rights (IPR) and so forth. IPR is essential for innovation as it enables actors to appropriate benefits of innovation and the system of corporate governance (Edquist et al., 1998). However, based on Malerba and Orsenigo (1997), a too stringent appropriability regime (such as high importance to IPR) may significantly limit diffusion of advanced technological knowledge and eventually block development of differentiated technological capabilities within an industry, which is referred as appropriability trap by Woolthuis et al. (2005).

As Wieczorek and Hekkert (2012) and Lipsey, Carlaw and Bekar (2005) indicate institutions are determined by their spatial, socio-cultural and historical specificity. Therefore, they are not only different among nations but also show variation regarding firms' response to them. As Whitley (2007) indicates different sets of institutions governing property rights, capital and labour markets lead to contrasting patterns of firms' innovation activities. According to Smith (1997), institutions are crucial to economic behaviour and performance. Legally or customarily, institutions, such as regulation, law, norms and culture, form 'rules of the game' or 'the codes of conduct' that evolve in their function to reduce uncertainty in the economic system. The evolutionary characteristics of institutions towards firms in their development of new products, processes and services constitute a major differentiating characteristic of NISs in market economies. In line with Smith (1997), several scholars stress the importance of institutions for the national economy. Sharif (2006) insists the importance of institutions and organisations be progressing sufficiently in their work towards development rather than only dealing with issues of basic poverty and illiteracy in emerging economies. Niosi (2011) warns that less efficient institutions trap most potential catchers- up. Therefore, institutions fulfil important roles. They gather and process information then make it accessible to economic agents (Turpin & Ghimire, 2012). However, they do constrain and enable actions because they allow anticipation of the behaviour of other agents (Niosi, 2010). All these discussions highlighted the importance of institutions as a dimension for NIS within the national context. The sub-section below discusses the measures of the dimension 'institution'.

Measurements of Institution

There are many classifications of institutions as discussed above; however, measurements in the form of hard and soft institutions are common. Hard or formal institutions may be a part of the framework of regulation, which consists of technical standards, labour law, risk management rules, health and safety regulations and so on. They are also part of a general legal system relating to contracts, employment, IPR within which actors (not only firms but also knowledge institutes and government) operate (Smith, 1999; Woolthuis et al., 2005; Lankhuizen & Woolthuis, 2003). Wieczorek and Hekkert (2012) highlighted that rules, laws, regulations and instructions as indications of hard institutions. Lankhuizen and Woolthuis (2003) added that these hard institutions regarding laws and regulations are often at the national level. They also include legal system relating to contracts and employment, intellectual property right (IPR) and so on.

The soft or informal institution includes social norms and values, culture, willingness to share resources with other actors (Saxenian, 1994). Also includes the entrepreneurial spirit within organisations, industries, regions or countries (Carlsson & Jacobsson, 1997), tendencies to trust (Fukuyama, 1995) and risk averseness (Woolthuis et al., 2005). Wieczorek and Hekkert, (2012) combine all these thoughts and list indicators of soft institutions as customs, everyday habits, routines, established practices, traditions, ways of conduct, norms and expectations. As this dimension is considered for national level, the indicators of the hard institution are suitable measurements as per the indication of Lankhuizen and Woolthuis (2003).

2.4.2.2. Infrastructure

Definition and Description

There is some confusion in the literature between institutions and infrastructure dimensions, and it is highlighted by Wieczorek and Hekkert (2012). Based on the authors, infrastructure does not have a steady position as a structural element of innovation systems, and there is no definitive agreement in key literature positions as to what the term infrastructure covers, which is also evident from Kuhlmann and Arnold (2001) and Schmoch, Rammer and Legier (2006). These authors use the term 'infrastructure' to encompass 'institutions', namely so-called 'framework conditions', institutional set-ups (rules, norms and social conduct), public utilities and policies. For the authors, infrastructure covers both institutions and other public utilities. Even when Tassey (1991) defined 'technology infrastructure', the author included both institutions and facilities. The author's definition is, 'the technology infrastructure consists of science, engineering and technological knowledge available to private industry. Human, institutional or facility forms' embody such knowledge' (Tassey, 1991, p. 347). However, this study takes a position to distinguish between 'infrastructure' and 'institution' as they require distinctively different resources and action plans. The infrastructure dimension discussed here is characterised by its vast scale, indivisibilities, and a very long time horizon of operation (Smith, 1999), which indicates that it is highly unlikely to produce adequate returns (ROI) for private parties to invest in them. Therefore, the government has a responsibility in addressing such infrastructural needs and preventing failures from occurring (Woolthuis et al., 2005).

For firms to succeed in innovation, they need reliable infrastructure to enable their everyday operations and support their long-term developments (Lankhuizen &

Woolthuis, 2003). The knowledge infrastructure, in particular, is emphasised in the field of innovation. O'Sullivan (2005) uses the term infrastructure in connection with the availability of finance for innovation in the form of venture capital, funds, subsidies or programmes. Link and Metcalfe (2008) analysed the whole set of dimensions of 'technology infrastructure' such as physical and virtual tools, methods and data. Smith (1997) emphasised the importance of the tangible physical and knowledge infrastructure. Tangible infrastructure plays an important role in establishing the dominance of technologies and in shaping technological trajectories, which affect the overall performance of innovation systems (Wieczorek & Hekkert, 2012). The subsection below discusses the measures of 'infrastructure' dimension.

Measurements of Infrastructure

Knowledge infrastructure (Lamprinopoulou, Renwick, Klerkx, Hermans, & Roep, 2014; Wieczorek & Hekkert, 2012; Smith, 1997), technology infrastructure (Tassey, 1991; Link & Metcalfe, 2008), physical infrastructure (Smith, 1997; Wieczorek & Hekkert, 2012; Lamprinopoulou et al., 2014), funding or finance infrastructure (Lamprinopoulou et al., 2014; Wieczorek & Hekkert, 2012; O'Sullivan, 2005) and science–technology infrastructure (Woolthuis et al., 2005) are some of the catetegories of 'infrastructure'. The scholarly works of these authors help deriving indicators of infrastructure discussed in the following paragraph.

The indicators for knowledge infrastructure involve R&D facilities, libraries, training systems, knowledge, expertise, know-how and strategic information (Lamprinopoulou et al., 2014; Wieczorek & Hekkert, 2012). Smith (1997) highlighted that universities, research labs, training systems, libraries and any other public and private organisations, whose role is production, maintenance, distribution, management and protection of knowledge, are the indicators of infrastructure for innovation. This conceptualisation has both physical and soft part of the infrastructure such as skills and expertise.

The indicators of technology infrastructure include generic technologies, infra-technologies, technical information, and research and test facilities. Also include less technically-explicit areas such as information relevant for strategic planning and market development, forums for joint industry-government planning and collaboration, and assignment of intellectual property rights (Tassey, 1991), and physical and virtual tools, methods and data (Link & Metcalfe, 2008).

The measures of physical infrastructure involve railroads, machines, buildings, harbours, artefacts, instruments, machines, telecom networks, and bridges and so on (Lamprinopoulou et al., 2014; Wieczorek & Hekkert, 2012: Smith 1997). These are constraints requiring significant investments that cannot be made independently by the actors of the system (Lamprinopoulou et al., 2014). However, this physical infrastructure plays a vital role in establishing the dominance of technologies and shaping technological trajectories, which affect the overall performance of innovation systems (Smith, 1997). Some empirical studies explicitly show the significance of physical infrastructure (such as rail-tracks) for the functioning of innovation systems and refer to its deficiency as a systemic problem (Woolthuis et al., 2005).

The indicators of financial or funding infrastructure are subsidies, grants, incentives from banks, financial programs (Lamprinopoulou et al., 2014; Wieczorek & Hekkert, 2012) and availability of finance for innovation in the form of venture capital, funds, subsidies or programmes (O'Sullivan, 2005). The indicators of communication and energy infrastructure as highlighted by Woolthuis et al. (2005) and Lankhuizen and Woolthuis (2003) are high-speed information and communication technology (ICT) infrastructure, broadband, telephone, energy supply and so on. The indicators of socio-technology infrastructure as highlighted by Woolthuis et al. (2005) and Lankhuizen and Woolthuis (2003) are the availability of scientific and applied knowledge and skills, testing facilities, possibilities for knowledge transfer, patents, training, education and so on.

2.4.2.3. Market Dimensions

Definition and Description

The assemblage of policy and market elements explain a country's innovative capability. Market dimension refers to positions of and relations between market parties such as a monopoly or lack of transparency and also imperfections in 'knowledge market' (Klerkx & Leeuwis, 2008; Klerkx et al., 2012). Metcalfe (2007) highlights the economic relevance of markets from an evolutionary viewpoint by indicating markets as instituted devices that promote the unpredictable growth of knowledge and its application through innovation and self-transformation of economic arrangements. According to Bleda and Del Rí (2013), the market is an evolutionary context that functions as a coordinating mechanism of knowledge and its carriers. In simple terms, evolutionary markets are adaptive markets. The authors added that market elements are necessary to coordinate knowledge and its carriers in an evolutionary context, and hence require explaining not only the capabilities of agents to perform operations (their operational rules) but also their ability to create, adopt and accumulate knowledge (their mechanism and constituent rules). However, Metcalfe (2005) has expressed market dimension as a complex emergent self-organising structure that arises because of coordination of knowledge and its carriers within a population. The function of the market for innovation is not only coordination of information and behaviour at an operational level but most importantly the coordination and growth of knowledge at a generic level (Bleda and Del Rí, 2013). The authors also added that evolutionary markets are knowledge-structuring and knowledge-growing systems. This imperfection is referred as dynamics of knowledge, which could lead to a market opportunity that enables innovation or market failure increasing transaction costs. As per the discussions of Cohendet and Meyer-Krahmer (2001), the dynamic knowledge (as conceived in evolutionary view) is the knowledge that underpins market operations. It has a structure, and its epistemic content and the way in which it changes do matter. Bleda and Del Rí (2013) added that novelty, order and structure in knowledge are created by coordination processes both at deep and surface level as a market for the application of this knowledge is formed. The coordination between deep (micro) and surface (macro) level becomes a problem if policies are devised at the surface level without the understanding of the deep level.

Dodgson, Hughes, Foster, and Metcalfe (2011) highlighted market elements as one of the critical elements of effective innovation policy in the NIS approach. According to the authors, markets are emergent regarding the facilitation of the trading of new products and services. Though markets can arise spontaneously, government's support can help develop them and make them work effectively. Therefore, markets differ depending on the national context in enabling complex economic systems to produce and deliver new products and services. As Bergek, Jacobsson, Carlsson, Lindmark, and Rickne (2008) indicated nations might differ regarding the existence of a market element, articulation of demand by potential customers or their capability to do so, price or performance of new product or services and uncertainties that prevail in related areas. Markets are critical devices in the process of 'competitive selection' that must occur if progress is to be made.

According to Bleda and Del Rí (2013), the market may not function well under three different conditions. They are deep coordination issues of knowledge or generic rules to fit together, surface coordination issues of market agents to interact and the operational issue of agents' activities and behaviours to connect. Deep coordination issue occurs when a new rule formed at the micro level by an entrepreneur is not synchronised at the mesoscale of the market. Surface coordination issue occurs if agents fail to coordinate or connect efficaciously for its adoption. These issues are due to organisational inertia (Nelson & Winter, 1982; Hannan & Freeman, 1989), lack of adaptive capacity of agents to the resistance, and the inability of agents to change their existing routines and practices particularly for cases that require significant adaptation and learning. Weber and Rohracher (2012) indicated market elements that are relevant for innovation policy based on NIS perspective as information asymmetries, knowledge spillover, externalisation of costs and over-exploitation of commons.

Information asymmetries refer to the uncertainty of outcomes and short time horizon of private investors leading to undersupply of funding for R&D (Weber & Rohracher, 2012). According to Woolthuis et al. (2005), asymmetric information is a condition for successful innovation rather than a market failure. Without asymmetry, there can neither be novelty nor variety (Hauknes & Nordgren, 1999). Faber and Hoppe (2013) also indicate that, in evolutionary approaches, asymmetry in information or skills will lead to a variety of preferences for both consumers and producers. This knowledge asymmetry provides considerable scope for improvement of demand-side dimension in innovation system studies (Geels, 2004; Witt, 2011).

Based on Weber and Rohracher (2012), public goods character of knowledge and leakage of knowledge is referred as knowledge spillover. Knowledge spill-over leads to socially sub-optimal investment in (basic) research and development. The other two market elements, the authors attempt to explain, are an externalisation of costs and over-exploitation of commons. While externalisation of costs refers to the possibility to externalise costs, 'exploitation of commons' refers to over usage of public resources in the absence of institutional rules that limit their exploitation (tragedy of the commons). These lead to innovations that can damage the environment or other social agents. These discussions highlight the importance of 'market' dimension in shaping innovation outcomes of firms. The following sub-section discusses the measures of 'market' dimension.

Measurements of Market

The availability of indicators of the market that is relevant to NIS is scarce in literature except for a brief indication of 'information asymmetry' and 'knowledge spillover'. The measures of information asymmetry include uncertainty about research outcome; undersupply of funding from private investors (Weber & Rohracher, 2012), and under the provision of care in protecting the quality and under the provision of information (Hennessy, Roosen, & Jensen, 2003). Further, Weber and Rohracher (2012) indicate that leakage of knowledge (in the form of an open source of information) investment for basic research and development as a measure of 'knowledge spillover'. However, measures of 'externalisation of costs' and 'over-exploitation of common' are not very obvious in literature.

2.4.2.4. Summary of Dimensions of NIS

This section of the literature indicates that demand-oriented NIS consists of two major constituents namely national contexts and firm attributes. Further, it discusses the major dimensions and measurements of each of those constituents. The discussions highlight the important dimensions of 'national context' as 'infrastructure', 'institution' and 'markets' and that of 'firms' as 'capability', 'interaction' and 'transformative attributes'. The major dimensions further comprise subcategories within. Figure 2.2 presents a summary of dimensions of demand-oriented NIS. The following section covers sectoral perspectives in NIS.

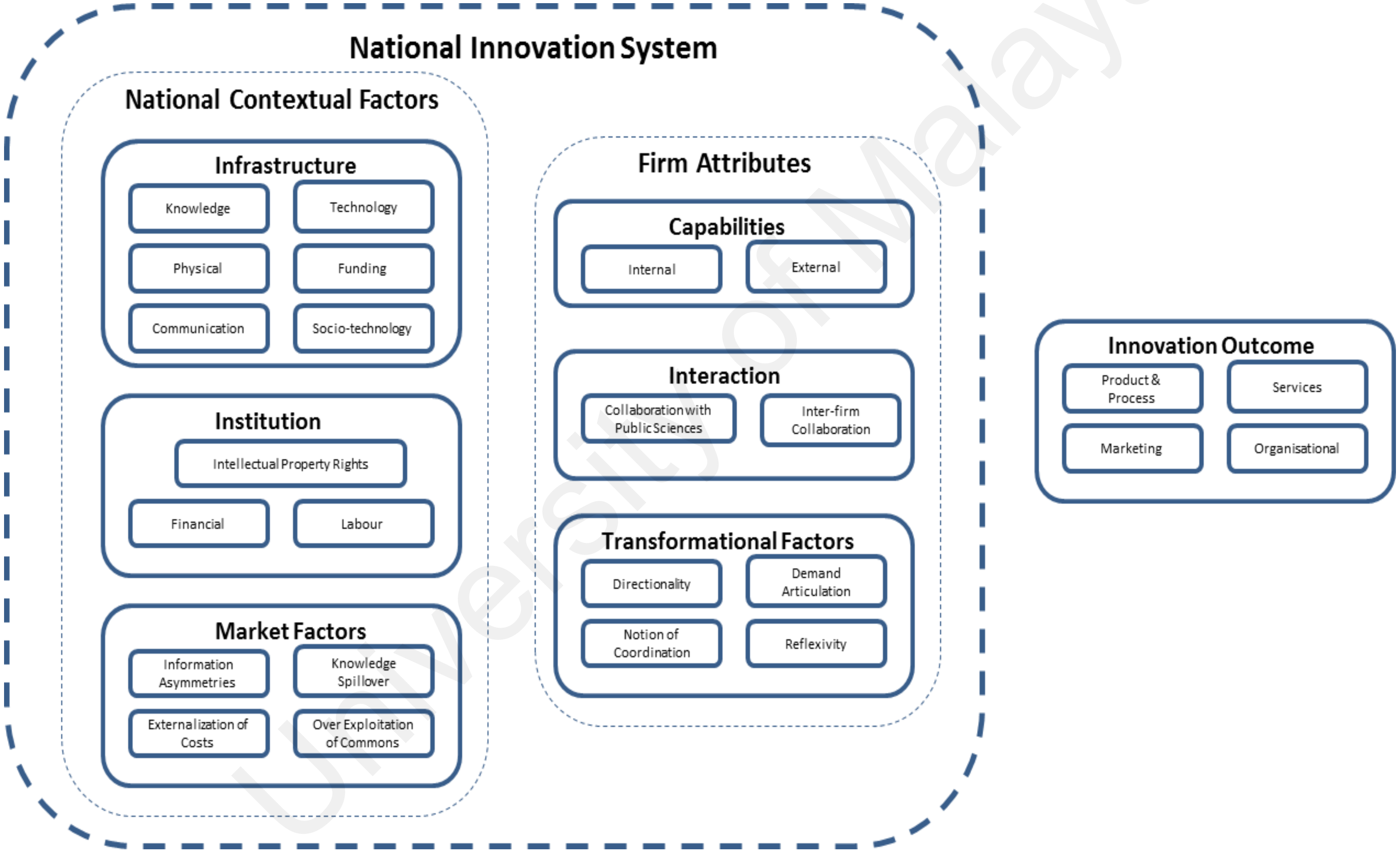

Figure 2.2: A Graphical Summary of Dimensions of Demand Oriented NIS

2.5. Sectoral Perspectives in National Innovation System

Sectors are heterogeneous within a national context. Sectoral perspective was contributed by many authors such as Breschi and Malerba (1997), Pavitt (1984), Malerba and Orsenigo (1997), and Malerba (2002), and Dosi, Marsili, Orsenigo and Salvatore (1995). Sectoral studies within the innovation system flourished as Sectoral Innovation System within Innovation system studies. Some of the recent studies involving sectoral innovation system are intermediaries in automotive sector of Thailand (Intarakumnerd & Chaoroenporn, 2013) and green energy innovations in the construction sector of Nordic countries (Faber & Hoppe, 2013). Also involve a study done in the pharmaceutical sector in Taiwan (Hu & Hung, 2014), a conceptual discussion on tourism sector (Weidenfeld & Hall, 2014), China's semiconductor sector (Lee & Kim, 2015) and forestry sector in the Czech Republic (Jarský, 2015). Considering Malaysia, studies by Chang, Rasiah, and Chan (2016) of the construction sector and Rajab, Abdullah, and Hamid (2017) of Nanotechnology sector seem to be prominent lately. These studies used sectoral innovation system framework to investigate issues specific to particular sectors.

An innovation system may be delimited nationally (regionally), sectorally, or according to technology or knowledge-based (Andersen, Andersen, Jensen, & Rasmussen, 2014) based on the issue to be addressed. As Andersen et al. (2014) highlighted, delimiting innovation system studies depends on the issue considered. As indicated in the scope of the study, the issue considered here is national context based and delimitation based on the nation is suitable here.

Based on Lundvall (2007), this study considers that sectoral perspective makes general understanding of innovation better in its own right. Sectoral perspective is often an operational method for understanding heterogeneity and dynamics of Innovation System at the national level. Lundvall (2007) and Chaminade et al. (2012) note that firms belonging to different sectors differ in how they innovate, interact with other firms and knowledge infrastructure and draw upon markets for labour, finance and intellectual property. Malerba (2005, p.385) defined sector as a "set of activities that are unified by some linked product groups for a given or emerging demand and which share some common knowledge". Though firms are heterogeneous, firms within a particular sector do have some commonalities regarding coping with technologies, searching around knowledge bases, undertaking production activities, and institutional setting embedded in, behavioural traits and range of learning patterns, behaviour and organisational form (Malerba, 2005). However, sectors differ in these commonalities and become heterogeneous. It is worth understanding heterogeneity among sectors to devise policies that have practical implications. Weber and Rohracher (2012) attributed the failure of innovation policies (to deal with long-term normative goals for a systemic change) to the need for policy coordination with sectors. Policies coordinated with sectors are demand-focused, and policies of these sorts have attracted greater attention (Edler & Georghiou, 2007). Arundel, Lorenz, Lundvall, and Valeyre (2007) answer the question of how to divide firms into sectors for policy purposes, as there are many categories available. The authors indicate that it is possible to divide the economy into two main sectors namely services and manufacturing and their proposal make sense for innovation system analysis.

The manufacturing sector provides critical products) that enable delivery of efficient and high-quality services, and the services sector provides critical services that enable production, distribution and consumption of effective and high-quality products (Tien, 2007). However, the demarcation between different economic sectors is not clear; this is especially true between manufacturing and services sectors, which are interdependent (Tien & Berg, 1995; Berg, Tien & Wallace, 2001). Majority of the studies on NIS focus on the manufacturing sector and most of the policies apply to the manufacturing sector. However, the importance of services sector cannot be overstated. It employs a large and growing proportion of workers in industrialised nations (Tien, 2007). Tien (2007) also indicated that the services sector of the United States of America (USA) includes a number of large industries, indeed, services employment in the USA is at 82.1 percent, while the remaining four economic sectors (manufacturing, construction, agriculture, and mining) together, can be considered to be the "goods" sector, employ the remaining 21.4 percent. This example shows the significance of the services sector.

In most of the developing countries, the services sector is the major contributor to the gross domestic product (GDP) including Malaysia. While the share of manufacturing continues to increase in Malaysia, services sector begins to show a distinct contribution to Malaysia's GDP since the 1990s (Asgari & Yen, 2009). These authors also added that Malaysia is experiencing the dominant feature of "post-industrial" stage in which industrial age goes through a transition towards an economy with s strong service industry. Further, the authors highlighted that services sector in Malaysia is starting to act as catalysts for growth as the government supports some of the industries within services sector (such as the shipping industry, tourism industry, education and health services, port facilities, and air transportation) through policy changes. Therefore, Pavitt (1984) posited the importance of sectors in innovation systems based on the idea that policy implications should be different for different sectors. Inter-sector difference plays a major role in shaping the NIS. Firms belonging to different sectors contribute differently to innovation processes and differ in how they innovate as indicated earlier in this section. Therefore, sectoral differences regarding manufacturing and services sectors can explain firms' response to national contexts, their innovation attributes and outcomes, which are critical to inform governments and policymakers.

This section explains the importance of sectoral demarcation between manufacturing and services sectors and the need to study them separately. This study proposes to investigate manufacturing and services sectors separately with empirical data for policy implications. The following section covers the research framework proposed for the study.

2.6. Research Framework

This part of the chapter describes the research framework based on the study purpose and research objectives presented in chapter 1. The framework presents national contextual and firm-related factors that influence innovation outcomes in the context of emerging economy. Systemic perspectives of innovation, evolutionary theories and development block theory form the foundation of the framework as discussed earlier in this chapter. This part of the chapter synthesises the discussion on dimensions of NIS to conceptualise the research framework.

2.6.1. Proposed Measures and Model

The literature review and theories reported earlier help developing measures of NIS and a research model depicting interrelationships among the measures leading to innovation outcomes. Proposed measures and the research model are presented in figures 2.3, 2.4

and 2.5. Six major dimensions of NIS leading to innovation outcomes are apparent from the literature namely infrastructure, institution, market factors, firm capability, interactions and transformational factors. These dimensions are prominent with sub-dimensions as per the literature discussed earlier and presented in figure 2.3. Furthermore, these dimensions are also categorised under national contexts and firm attributes as discussed earlier. It is also discussed in the literature and proposed here that existence of these measures of NIS (both main and sub-dimensions) differ between manufacturing and services sectors due to their differing natures and perspectives towards innovation.

Among the measures, exogenous variables are national contextual measures involving infrastructure, institution and market factors. Firm attributes including capability, interaction and transformational factors and innovation outcomes constituted endogenous variables. The proposed model presents measures of NIS and their interrelationships in influencing innovation outcomes. Therefore, the model proposed national contextual measures as antecedents of firm attributes, whereas firms' attributes (capability, interactions and transformative attributes) and innovation outcomes are proposed as consequences of firm attributes influenced by national contexts (refer Figure 2.5). This model considers firm attributes as the overall stimulus developed through national infrastructure, institutional provisions and market conditions. The two major constituents of NIS, national contextual factors and firm attributes are developed based on discussions of Carlsson at al. (2002) and Edquist and Hommen (2008) for national contextual factors and Lundvall (2007), Whitley (2007) and Weber and Rohracher (2012) for firm attributes. For a discussion of dimensions from the viewpoint of system construction, this study considers the perspectives of Carlsson at al. (2002) and Edquist and Hommen (2008). Based on the authors, a 'system' has three distinct features and are two types of constituents regarding components and relations among them, dedication to perform or achieve something and ability to discriminate between the system and the rest of the world (possibility to identify the boundaries). Edquist and Hommen (2008) indicate that constituents regarding components and relations form a coherent whole, with properties different from those of the constituents.

Sectors are heterogeneous within a national context. Based on Breschi and Malerba (1997) and Lundvall (2007), this study considers that sectoral perspectives make general understanding of innovation better in its own right. Sectoral perspective is often an operational method for understanding heterogeneity and dynamics of innovation system at national level. Firms belonging to different sectors differ in how they innovate, interact with other firms and knowledge infrastructure, and draw upon markets for labour, finance and intellectual property (Lundvall, 2007). Therefore, separate investigation of sectors using empirical data is necessary.

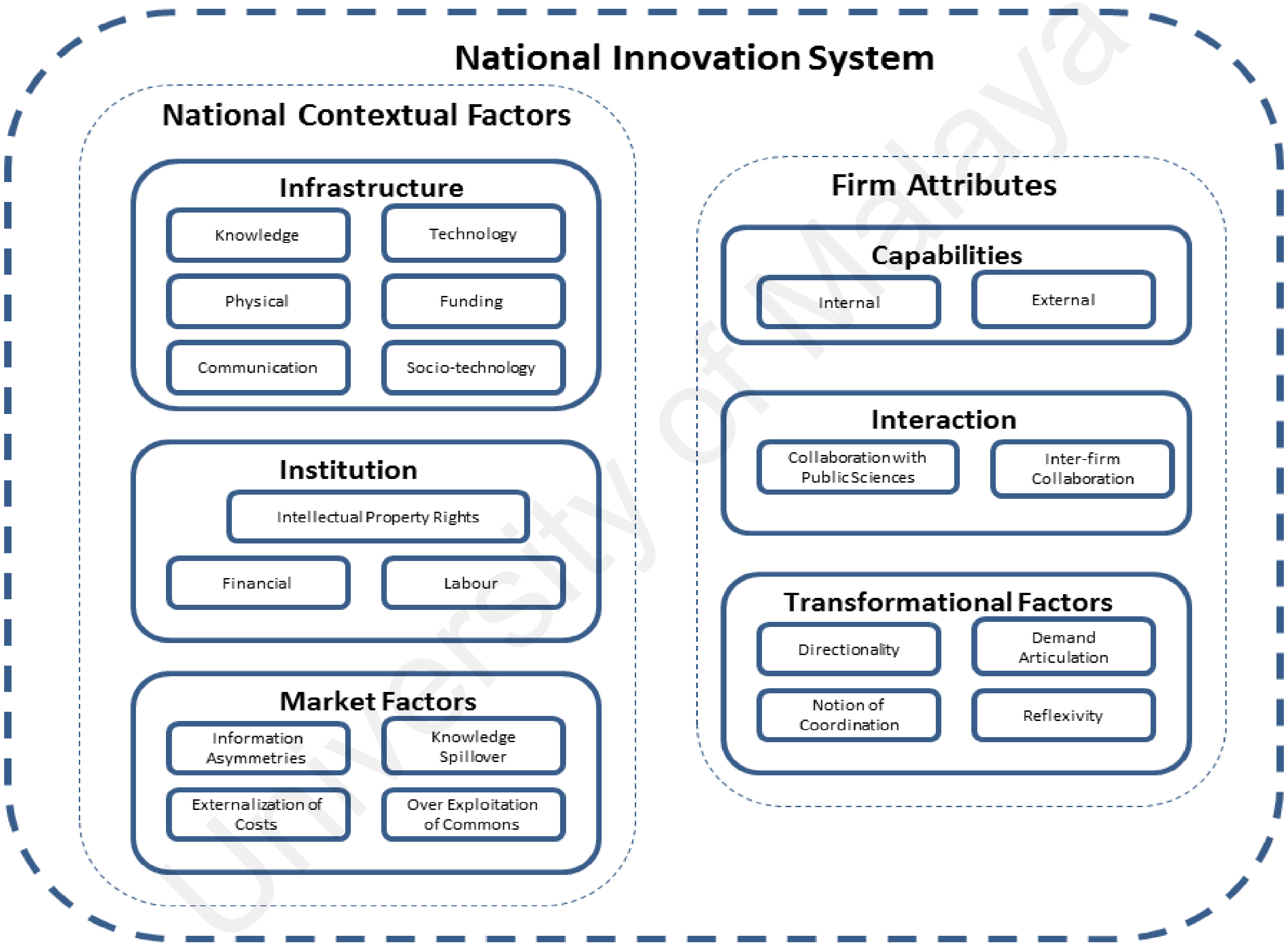

Figure 2.3: Proposed Measures or Dimensions and sub-dimensions of National Innovation System

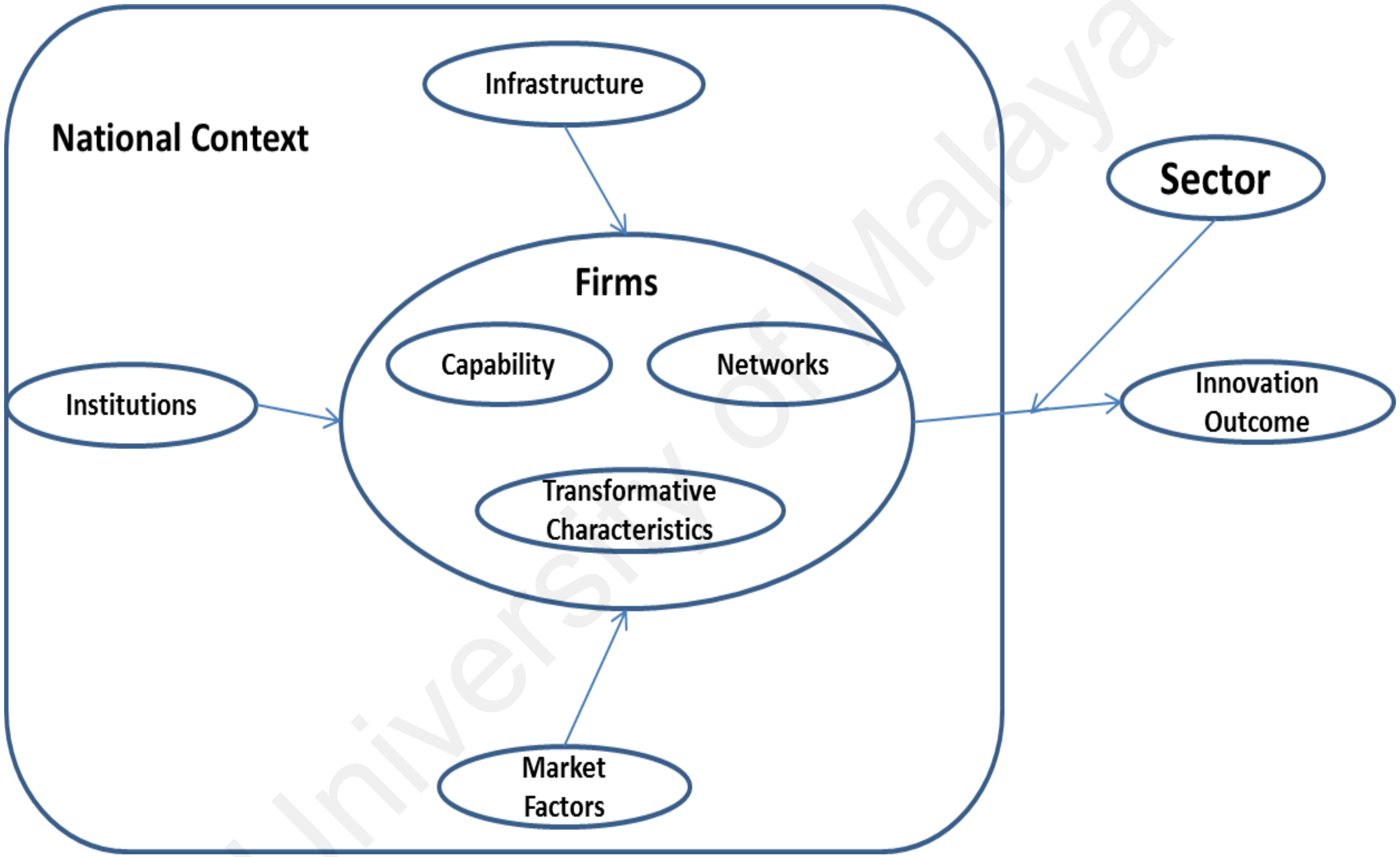

Figure 2.4: Proposed Measures or Dimensions of National Innovation System with Sectoral Differences

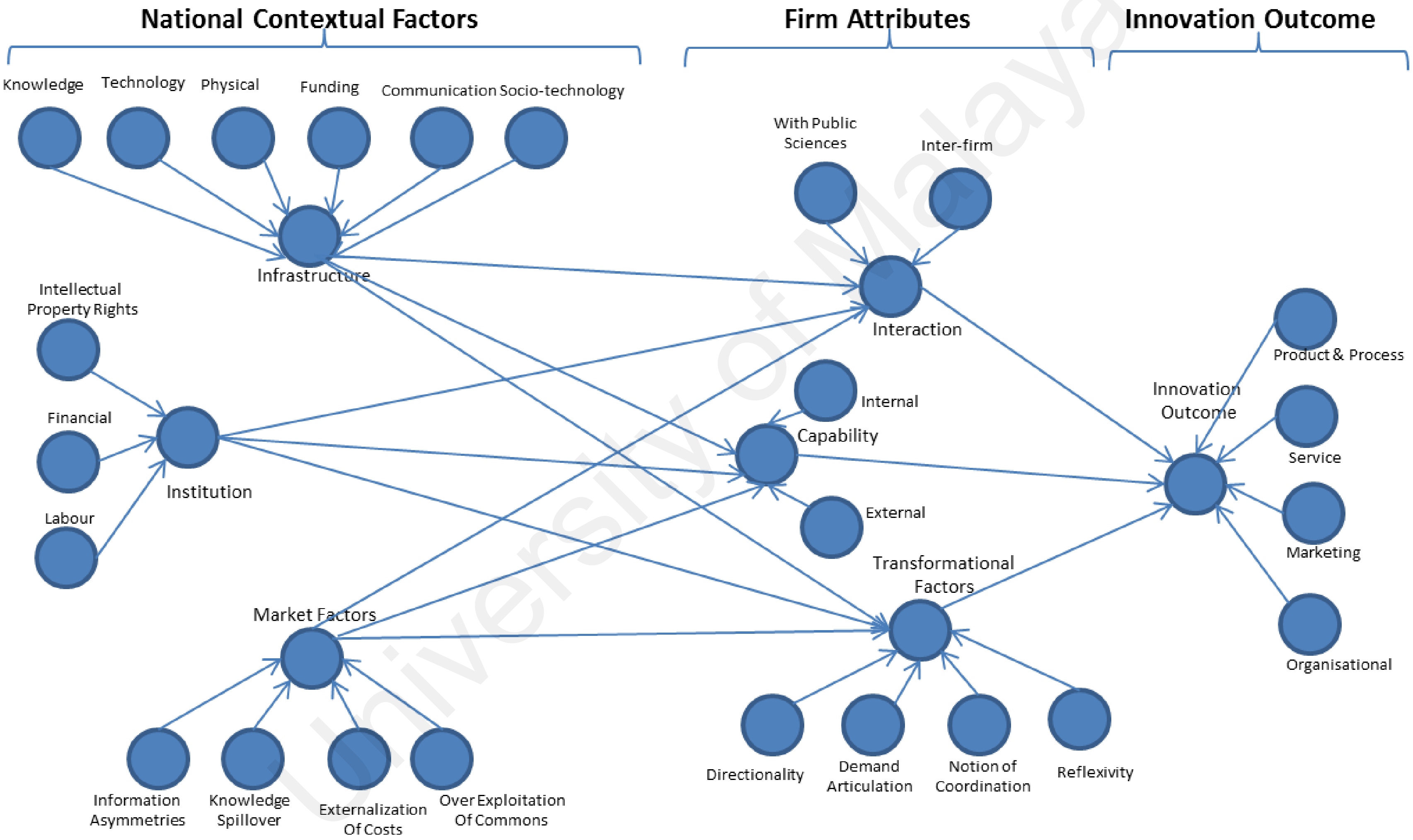

Figure 2.5: Proposed Research Model

2.7. Hypothesis Development

This part of the chapter presents hypotheses based on the study purpose and research issues presented in chapter 1. The conceptualisations of hypotheses to answer the research issues are on three topics namely measures of NIS, systemic problems and enablers, and interrelationships among the dimensions.

2.7.1. Measures of National Innovation System

National Innovation System (NIS) could provide a general framework to structure the elements regarding firms' attributes and national contextual factors towards national innovation outcomes. Although literature in this area is expanding, there are two prominent traditions by Nelson and Lundvall are apparent in the literature. However, both the traditions witness a common problem that is to measure NIS. The first objective of this study is to fill this gap by providing a base scale and methodology for measuring NIS based on perspectives of firms.

Chaminade et al. (2012) answer the question of whether NIS should be measured or not, and, if so, why. The authors' brief answer to this question is 'yes', because 'policies based on innovation system approach often collide with old paradigms, rationales and instruments (Intarakumnerd & Chaminade, 2007) and, more often than not, end up being one-size-fits-all-policies rather than policies that take the specificities of the system into account. The authors also indicate that there are several attempts to describe rather than to define and measure NIS.

Nasierowski and Arcelus (1999) attribute early attempts to measure NIS to Pavitt (1985) and Evenson (1991). They tested relationships between selected "inputs" (e.g., expenditures on R&D, quality of engineers/scientists) and selected “outputs" (e.g., patents and publication counts). Then, there were attempts to use measures to examine efficiency of selected countries’ NIS (Nelson, 1993), fundamentals of efficiency of technology systems (Porter, 1990) and comparisons between national solutions (Nelson, 1993; Maital, Frenkel, Grupp & Kochatzky 1994; Soete & Verspagen, 1991; Dahlman, 1994). The following section discusses the status of empirical studies in NIS.

2.7.1.1. Status of Empirical Studies in NIS

A compilation of studies that attempted to measure NIS is in Appendix A-1. A compilation of studies that attempted to evaluate or measure NIS (regarding either dimensions, elements or components) is in Appendix A-1. The compilation was able to locate at least 24 studies that evaluate or measure NIS. Out of the 24 studies reviewed, only 29% of them attempt to measure NIS from demand-side, which is from firm’s perspective. Mostly the studies are skewed to considering national characteristics through national aggregate estimates derived from national or world organisations’ reports such as in Nasierowski and Arcelus (1999), Marklund, Nilsson, Sandgren, Thorslund, and Ullström (2003) and Godinho, Mendonça, and Pereira (2003) and so on. Based on Niosi et al. (1993), measures of national characteristics are readily available but are crude measures. The authors also add that empirical studies using these measures to study NIS have relied upon a vast array of indicators. These indicators include not only characteristics of actors (number, size, and degree of centralization of innovation units) and flows (technological, financial, social, commercial, and legal or political), but also performance of systems either directly (through patents per researcher or dollar) or indirectly (through economic or industrial performance).

It was also noted that most of the studies (13 out of 24, 54%) are comparative studies. Indicators used in these studies skew to research and development (R&D), and science and technology (S&T). David and Foray (1995) suggest assessing innovation systems by different methods other than comparing some absolute input measures such as R&D expenditures with output indicators such as patents or high- tech products. However, Dodgson et al. (2011) indicate that comparative indicators and methodologies continue leading in the studies of innovation systems quoting Gault (2007) and OECD (2005). The authors also commented that the studies of NIS relied on highly piecemeal and misleading indicators of performance such as the USA patenting. Based on the authors, the fundamental critique is the view that applications of the NIS approach are often too static, descriptive and mechanical, and focus disproportionately on science and technology as opposed to other loci of innovation. NIS requires treatment in a whole as a multidimensional concept, which is emphasised in the study of Godinho et al. (2003). However, this study uses national estimates from world organisations' reports to compare 14 countries from Europe, America and Asia involving both developed and developing nations. The dimensions proposed are not theoretically driven and the authors themselves have highlighted this.

Smith (1995) comments that system approaches have been notable more for their conceptual innovations and novelty of their approaches rather than for quantification of empirical descriptions. However, the review in Appendix A-1 shows considerable empirical investigations in this area. The review shows 16 quantitative (67% including two simulations) and six qualitative (25%) studies. The remaining two (8%) studies are conceptual. However, these studies mostly focused on aggregate scores from national or world organisations' reports except for Jensen, Johnson, Lorenz, and Lundvall (2007), Leiponen and Drejer (2007), Srholec and Verspagen (2008), Chaminade et al., (2012) and

Meuer et al. (2015). These studies focused on firm-level data from the perspective of firms. Lundvall, who organised the Danish Innovation System in comparative perspective (the Disko-project) commented later that the approach used in Danish Innovation System for different reasons, appear to be difficult to apply when it comes to studying the reality of emerging economies (Lundvall, 2005). The reasons given by the author are mainly the status of firms in emerging economies and are summarised here. First, the population of firms is less engaged in innovation and learning, to begin with, and second, it might be virtually impossible to gather data on what goes on inside firms through surveys and registered data may also be scarce and unreliable. The standard indicators of research, innovation and competence may not capture the reality of innovation systems (Lundvall, 2005, pp.30-1). The author also indicates that to find ways to define embryonic elements of the innovation process is a challenge and to develop alternative indicators that capture these elements is a major challenge. These challenges require testing different concepts and ideas in empirical work. However, keeping the firm in focus is crucial for understanding what works and what does not work in the national innovation system. The experience from the former Soviet Union as well as from middle-income developing countries is that separation, and lack of interaction between knowledge infrastructure and firms is the most important element slowing down processes of learning and competence building with relevance for economic development (Lundvall, 2005). In developing countries, industries' demand for highly skilled labour is quite limited, and infrastructure may be another issue. Also, the primary focus of governments of emerging economies is to create order and fulfil necessary living conditions based on material conditions of the country. Most of the studies in the review, as shown in Appendix A-1, focus on developed economies or a combination of both (developed and developing) without considering the differences.

2.7.1.2. Status of Empirical Studies in NIS of Emerging Economies

A very few studies (5 out of 24) attempt to evaluate or measure NIS in emerging economies. Among them, three are qualitative, one is a simulation, and another one is quantitative. This section discusses these five studies. Liu and White (2001) investigated China's NIS under planning and compared it with the existing one using national aggregate data. The authors also indicate that studies of less developed and transitional economies' innovation systems reflect an implicit assumption of convergence. However, shortcomings in actors' performance or resistance to policy objectives are something to overcome rather than a direct application of a system from a different context. The assumptions of national innovation systems converging on a single "best" organisational and policy structure are questionable. Chang and Shih (2004) attempt presenting an analytical framework to evaluate structural characteristics and efficiency of innovation systems and using it to compare two different innovation systems of Taiwan and China. However, the measures used by the authors focused only on institutions covering institutional functions and interactions of institutions. Both of these studies are qualitative mainly case studies descriptively using national aggregate data for discussion purposes.

Another qualitative study that uses firms' perspective and firm-level data is from Thailand by Intarakumnerd, Chairatana, and Tangchitpiboon (2002). In this study, the authors attempt to understand national innovation system (NIS) in a developing country, which is less successful in technological catching-up. The authors consider only actors and their linkages as measures. This study concludes that support of NIS to industrial technology development remains weak and fragmented in Thailand, which is mainly due to a mismatch between the states of economic structural development following developed economy and development level of actual NIS.

A simulation exercise by Lee and Von Tunzelmann (2005) in Taiwan attempts to develop a mathematical model of the NIS. However, data for this study is from Integrated Circuit (IC) industry, and the measures focus on technology and industry. It used System Dynamics Simulation. The drawbacks of this method are assumptions must be accurate, and data collection and model formulation should be cross-referenced. These drawbacks challenge the validity of the measures and model. Another quantitative study carried out by Chaminade et al. (2012) contributed in terms of providing a framework to identify systemic problems in a given system of innovation and test the framework empirically. However, the dimensions derived from this study are systemic problem-oriented and not general theory driven.

2.7.1.3. Status of Measures of NIS for Emerging Economies

While some methodological problems may account for continuing uncertainties regarding this issue, two of them appear to be of particular relevance for addressing this question. Most studies covered issues of NIS conceptually, qualitatively or descriptively with aggregate national data such as Nasierowski and Arcelus (1999), Godinho et al. (2003), Liu and White (2001), Chang and Shih (2004), Marklund et al., (2003) and so on. These authors propose analytical frameworks and qualitatively or descriptively assess the performance of NIS or strengths and weaknesses of NIS. There are five quantitative studies that used data from firms' perspective using either innovation surveys (Leiponen & Drejer, 2007; Srholec & Verspagen, 2008; Chaminade et al., 2012; Meuer et al., 2015) or a survey conducted in firms (Jensen et al., 2007). Among these studies, only Chaminade et al. (2012) is from Asia and emerging economy while the study of Srholec and Verspagen (2008) include EU members (combination of both developed and emerging economies) and the rest are from Europe and developed economies.

Most of these quantitative studies have focused on some aspects of NIS or sub-sectors such as Jensen et al. (2007) looking into modes of learning, Leiponen and Drejer (2007) into employee innovation intensity and Meuer et al. (2015) into institutions and firms. A very few studies can be quoted for considering the whole of the system considering NIS as a multidimensional concept (Godinho et al., 2003; Srholec & Verspagen, 2008; Chaminade et al., 2012). Though the study by Godinho et al. (2003) is quantitative, it mainly focused on the descriptive analysis of world organisations' aggregate estimates for comparative purposes, and the dimensions are not theoretically driven as stated by the authors. The other two quantitative studies (Srholec & Verspagen, 2008; Chaminade et al., 2012) used data from firms' perspective and unravelled all possible dimensions from firms' activities. The dimensions of these studies are skewed to strategies and systemic problems.

Firms are heterogeneous in their innovation behaviour (Christensen, 2002; Massini, Lewin & Greve, 2005); however, understanding of this heterogeneity in NIS remains unclear. As Wieczorek and Hekkert (2012) and Lamprinopoulou et al. (2014) indicate, NIS is composed of several building blocks or dimensions when it is considered for policy purposes. Scholars have discussed these dimensions conceptually and qualitatively. There is some consensus about the existence of structural, market and transformational dimensions in NIS based on Wieczorek and Hekkert (2012) and Lamprinopoulou et al. (2014). The founding idea of dimensions of demand-oriented NIS is discussed in topic 2.2.2, which is followed by a conceptual and qualitative discussion of the dimensions and their measures in topic 2.4. The principal and sub-dimensions identified from the literature are presented in figure 2.3. However, the extents to which these elements empirically describe NIS require further investigation.

Also, quantitative studies in this area did not take into account the fact that primary elements of the system correlate with each other and often co-occur in the same system, and thus, the presence of higher-order factors, which may account better for correlations among elements, gets undetected. Based on the idea of the market by Bleda and Del Río (2013), this study argues that generic structure of NIS thus emerges as a two-level construct that is composed of 'deep' level of ideas or generic rules and 'surface' level composed of their actualisations in carriers. Dopfer and Potts (2009) explain that at the deep level, there is a deep structure of interrelated ideas and there is a surface structure of interrelated components stated regarding actualisation processes on the surface level. This study represents the general explanatory framework that relies on the core theories of the scientific worldview, so that proposed statement of investigation is not an ad hoc hypothesis. According to Vicari (2008), the explanatory framework could be a macro-macro explanation to explain the earlier event to the later event. Here both explanans (a phenomenon to be explained) and explanandum (explanations) are at the macro-level. The author also added that there might be situations in which, there is no time gap between cause and effect (realised simultaneously), but explain features of the surface or macro-phenomena regarding micro-phenomena. While the micro-features emerge as the rules of the game (explanandum), macro patterns (explanans) simultaneously emerge as the causal power or carriers. These micro-macro explanations are suitable for demand-oriented NIS that focuses on firms' activities as a part of the national system (refer to a bottom-up, no-time gap effect).This discussion triggers the idea of identifying fundamental first- and second-order dimensions (hierarchical), which could allow governments and firms to understand micro aspects at the macro level to organise NIS to produce desired innovation outcomes and manage enablers and barriers.

Only two previous studies (Chaminade et al., 2012; Srholec & Verspagen, 2008) have empirically determined the higher-order factor structure of NIS. However, these two studies are mainly procedural driven and try to identify systemic problems (Chaminade et al., 2012) and firms' innovation strategies (Srholec & Verspagen, 2008). Srholec and Verspagen (2008) studied the third Community Innovation Survey (CIS-3) provided by Eurostat for the period from 1998 to 2000. This study extracted 13 first-order and 4 second-order factors. The second-order factors extracted represent research, user, external, and production strategies of firms for innovation. Chaminade et al. (2012) studied Thai Innovation Survey and extracted 16 first-order and 4 second-order factors. The second-order factors extracted are problems related to institutions, science and technology infrastructure, network and support services. These studies differ considerably regarding their outcomes, which leaves a gap in the understanding of the dimensions or measures of NIS.

It is, therefore, hypothesised:

$H_{1.0}$*:** ***There exists a hierarchical factor structure (latent constructs) of the firm and national context-related factors in the observations of firms' innovation activities within NIS.

$H_{1.1}$: *There exists a first-order factor structure of the firm and national context-related factors in the observations of firms' innovation activities in manufacturing and services sectors within NIS.*

$H_{1.2}$: *There exists a second-order factor structure of the firm and national context-related factors in the observations of firms' innovation activities in manufacturing and services sectors within NIS.*

$H_{1.3}$: Firm and context related factors within NIS differ between manufacturing and services sectors.

These first- and second-order dimensions of NIS could possibility become enablers or problems to realise innovation outcomes. The following section discusses the gap in the understanding of systemic problems and enablers.

2.7.2. Systemic Problems and Enablers

Innovation literature refers to problems that hinder the development of innovation systems as systemic problems, failures or weaknesses (Wieczorek & Hekkert, 2012). The dimensions that support in realising innovation outcomes are enablers. The existence of enablers and problems and the need to consider them as innovation policy rationales are widely recognised in most 'systemic' innovation literature. System failure or systemic problems or system imperfection arguments refer to the sub-optimal operation of innovation systems (Weber and Rohracher, 2012). The evaluation of systemic problems is critical for stimulating and thus prioritising specific innovation activities proactively to exploit opportunities that could contribute to the direction of desired long-term transformative change (Kubeczko and Weber, 2009).

Various authors, such as Carlsson and Jacobson (1997), Smith (1997), Malerba and Orsenigo (1997), Johnson and Gregersen (1994) and Edquist et al. (1998), can be noted for studying systemic imperfections. Based on discussions of several authors, Lankhuizen and Woolthuis, (2003) compiled a list of system imperfections, which are discussed here. Infrastructure failures (Smith 1999; Edquist et al., 1998) indicate lack of physical infrastructure that actors need to function (such as information technology, telecom and roads) and science and technology infrastructure (such as universities, research labs and so on). Transition failures (Smith, 1999) refer to the inability of firms to adapt to new technological developments. Lock-in or path dependency failures (Smith, 1999) specify the inability of complete (social) systems to adapt to new technological paradigms. Edquist et al. (1998) address the same failure but do not distinguish strictly between transition and lock-in failure. Hard institutional failures are failures in the framework of regulation and general legal system (Smith 1999). These institutions are for a specific purpose (Edquist et al. 1998) and, therefore, Johnson and Gregersen (1994) refer to them as formal institutions. Soft institutional failures are failures in social institutions such as political, cultural and social values (Smith 1999, Carlsson & Jacobson 1997). These institutions evolve spontaneously (Edquist et al. 1998) and, therefore, Johnson and Gregersen (1994) refer to them as informal institutions. Carlsson and Jacobson (1997) refer strong network failures as 'blindness' that evolves if actors have close links and look beyond for new developments; and weak network failures as the lack of linkages between actors, which lead to the insufficient use of complementarities, interactive learning and creating new ideas. Malerba and Orsenigo (1997) refer to the same phenomenon as dynamic complementarities failure. Capability failures (Smith, 1999; Malerba & Orsenigo, 1997) refer to the phenomenon that firms, especially small firms, may lack capabilities to learn rapidly and efficiently locking into existing technologies, thus being unable to leap to new technologies. Though every study on systemic issues had its list of potential systemic problems; these issues can be pinned down to infrastructure, capability, network, institutional, transition and lock-in problems (Chaminade & Edquist, 2006). However, Chaminade et al., (2012) highlight that none of the studies hitherto offer any empirical evidence of such problems or suggest how they can be identified empirically.

Faber and Hoppe (2013) studied energy innovation system and pointed out that barrier and trigger exist in all systems for innovation. The authors highlighted that it is important to assess and address any issues within the system for its performance, but it is equally important to assess their effect in combination with all the elements. Ultimately, the combination of all the barriers and triggers together determine conditions of success or failure. OECD (1997) suggested the concept of NIS as a useful tool to unravel systemic issues, which may impede innovation performance. The actors within a system, as well as contextual factors, are all crucial elements of any given system for creation and use of knowledge for economic purposes (Sharif, 2006). The problems in dimensions of NIS may affect the system performance. However, conceptual and qualitative explanations of this may not be of practical help to governments in devising policy.

The review of the literature on dimensions of NIS in Appendix A-1 includes five (5) studies that evaluated NIS using systemic problems. Among them, two (Weber & Rohracher, 2012; Wieczorek & Hekkert, 2012) are conceptual papers and two (Woolthuis et al., 2005; Lamprinopoulou et al., 2014) are qualitative papers from developed economies Netherland and Scotland respectively. Only one of them by Chaminade et al. (2012) is a quantitative investigation from Thailand, an emerging economy. However, the study concluded with systemic problems without investigating their combined effect on performance.

When technical blocks are freed, and appropriate enablers are discovered and enabled, the conditions would allow innovation to take place (Cumming, 1998). Therefore, it is vital to identify enablers and problems of innovation systems. Chaminade et al., (2012) indicate that some potentially significant problems in the innovation system are related either to components of the system (organisations, institutions or relationships) or to the evolution of the system over time. Woolthuis et al., (2005) indicate that systemic problems are factors that negatively influence the direction and speed of innovation processes and hinder development and functioning of innovation systems. These discussions lead to an argument that based on the direction of influence on innovation outcomes; dimensions of NIS become either enablers or problems of innovation systems. Hence, the effect of dimensions, considering the multi-dimensional aspect of NIS as a whole, on innovation performance is worth investigating. Therefore, the following hypothesis is proposed:

$H_{2.0}$*:** ***The dimensions (both first and second order) of NIS regarding firm attributes and their contexts have a significant effect on innovation outcomes as enablers or problems.

$H_{2.1}$: *The dimensions (both first and second order) of NIS regarding firm attributes and their contexts have a significant effect on innovation outcomes in the manufacturing sector.*

$H_{2.2}$: *The dimensions (both first and second order) of NIS regarding firm attributes and their contexts have a significant effect on innovation outcomes in the services sector.*

$H_{2.3}$: *There is a difference between manufacturing and services sectors in the direct influence of firm attributes and their contexts on innovation outcomes in NIS.*

2.7.3. Interrelationships

`Systems' approaches to innovation are founded on one of the most persistent themes in modern innovation studies that firms cannot be understood purely regarding independent decision-making at the level of the firm (Smith, 2000). In institutional approach too, context makes a difference when it comes to how agents interact and learn (Johnson et al., 2003). Innovation involves complex interactions between a firm and its environment (Smith, 2000). Here, the environment involves broader factors shaping the behaviour of firms including social and perhaps cultural context, institutional and organisational framework, infrastructures, and processes that create and distribute scientific knowledge. Environmental conditions are dynamic and vary even if they are specific to national or regional contexts. Lundvall (2005) express the same view indicating that firms' innovative activities are dependent on national education systems, labour markets, financial markets, intellectual property rights, competition in product markets and welfare regimes. The primary argument of systems theories is that system conditions have a decisive impact on the extent firms can make innovation decisions and modes of innovation undertaken (Smith, 2000). Based on Samara, Georgiadis, and Bakouros (2012), understanding these dynamics is one of the central topics in the studies of NIS, mainly under the macroeconomic concept.

Based on Hekkert, Negro, Heimeriks, and Harmsen (2011) and Smith (2000), innovation is a collective activity. It takes place within the context of a wider system. The innovative performance of an economy depends not only on how individual dimensions of NIS perform in isolation, but also on how they relate with each other as elements of a collective system of knowledge creation and use (Rycroft & Kash, 2004; Calia, Guerrini & Moura, 2007), which is subjected to dynamic processes (Smith, 2001). Furthermore, as Johnson (1997) indicates, innovation systems are social systems because they consist of social actors namely institutions and organisations. Therefore, they comprise of sets of habits, practices and rules for participating social actors. The nature of social systems is dynamic and open to external interactions (Lundvall, 1992), which can grow and be modified by the context in which they operate irreversibly. As Lundvall (2007) highlights, the innovation process may be seen as an intricate interplay between micro and macro phenomena where micro-processes shape macro-structures condition micro-dynamics and vice versa. On this basis, the author defined innovation system in two parts, a core and a broader setting around this core. As indicated by the author, the core of the innovation system is 'firms'. This study looks into firms (the core) regarding their capability, interactions and transformative actions. Patana et al. (2013) highlight that to explain the core of the NIS (firms), there is a need for a broader setting around the core. Patana et al. (2013) and Lundvall (2007) explain the broader setting regarding national aspects including national education systems, labour markets, financial markets, intellectual property rights, competition in product markets and welfare regimes. This study considers the broader set of national contextual factors. In innovation system research, innovation and development of industries depend on complex interactions between firms and their environment.

Weber and Rohracher (2012, p.1038) emphasised that 'innovation systems approaches put emphasis on innovation-activities of firms as key actors in economic and innovation processes and on systemic contexts which limit, direct or support their innovation activities and capabilities'. Also, the authors indicated that these systemic contextual differences, regarding institutions, institutional settings, knowledge infrastructures, structures for corporate financing, the organisation of research and education, the characteristics of labour markets, tax regimes or patent legislation, would affect the capacity and styles or activities of firms and other actors to innovate. National contexts can also facilitate creating synergies and spillover effects and helping firms to adapt to directed transformations. These discussions lead to an understanding that innovation policies aiming at creating a national environment for firms, which is more conducive to their innovative capabilities, would enable NIS to achieve its objectives of catching up and economic development. Therefore, there is a need to understand interrelationships among dimensions of national contexts, firm attributes and innovation outcomes. Smith (2000) agrees on the practical relevance of this understanding for innovation policies. However, these interrelationships are neither explained well by standard economic theory's supply-oriented market failure explanations of the need for government intervention in the innovation process nor is it adequately represented by the associated linear model of innovation (Edquist & Hommen, 1999). Therefore extending knowledge in the area of Innovation System (IS) is of theoretical and policy relevance.

A review of studies related to dimensions or measures of NIS showed a considerable number of studies (14 out of 24) that explored interrelationships. Among these studies, eight (8) of them used national, or world organisations' estimates and six (6) used data based on firms' perspectives. Six (6) studies out of the 14 used econometric analysis using regression, one (1) used panel co-integration analysis, one (1) structural equation modelling, one (1) data envelopment analysis, two (2) simulations and three (3) cluster or factor or a combination of both analyses. Among these studies, Nasierowski and Arcelus (1999), Faber and Hesen (2004) and Guan and Chen (2012) establish some causal interrelationships using national or world organisations' aggregate estimates. However, these studies treated NIS as a sector with inputs, moderators/ processes and outputs. Their measures skew to national aggregate estimates on R&D, S&T and other national characteristics such as employment, literacy rate and so on. These studies also treated developed and emerging economies in a similar manner. Therefore, the findings of these studies are questionable for emerging economies with demand orientation due to the disparity in the national set-up of these economies.

The two (2) studies (Lee & Von Tunzelmann, 2005; Samara et al., 2012) that used simulation method are questionable too due to the challenges in validating their assumptions and appropriateness of data. Also, they focus on specific aspects of NIS such as technology and industry systems within the nation (Lee & Von Tunzelmann, 2005) and functional structure (Samara et al., 2012). Also, specific aspects such as work organisation (Arundel et al., 2007), national capabilities (Fagerberg & Srholec, 2008), national and R&D characteristics (Gao & Guan, 2009), national innovative capability, absorptive capacity, income level (Castellacci & Natera, 2013), modes of learning in terms of 'doing, using and interacting' (DUI) and 'science, technology and innovation' (STI) modes (Jensen et al., 2007), institutional arrangements and organisations (firms) (Meuer et al., 2015) are covered in previous studies. However, these studies do not address the concern of complex interactions between a firm and its environment. Therefore, there is a lack of understanding on how the national environment shapes the behaviour of firms. The following hypothesis is to address this gap.

***$H_{3.0}$*: The effect of NIS contextual factors on innovation outcomes is intervened or mediated by firm attributes**

$H_{3.1}$: The effect of NIS contextual factors on innovation outcomes is intervened or mediated by firm attributes in the manufacturing sector.

H3.2: *The effect of NIS contextual factors on innovation outcomes is intervened or mediated by firm attributes in the services sector.*

H3.3: *There is a difference between manufacturing and services sectors in the effect of NIS contextual factors on innovation outcomes intervened by firm attributes.*

2.8. Summary

As this study looks into demand-oriented NIS for system promotion, demand-oriented theories or approaches such as system approaches to innovation, interactive learning theories and development block approach form the foundations of NIS for this study. These approaches explain the dimensions of NIS. 'National context' and 'firms' are the two major constituents of demand-oriented NIS. The discussions highlighted that 'infrastructure', 'institution' and 'markets' as macro dimensions of 'national context' and 'capability', 'interaction' and 'transformative attributes' as that of firms'. Further, this chapter covers the importance of sectoral demarcation between manufacturing and services sectors and the need to study them separately. The extant literature on the concept of NIS and its dimensions discussed in this chapter, form the basis for the proposed research framework. The chapter also argues that there is an existence of multidimensional hierarchical factor structure (latent constructs) of firm attributes and national context in the observations of firms' innovation activities representing NIS. Also, the possibility to evaluate systemic problems and enablers from these dimensions, and an opportunity to unravel interrelationships among dimensions of national contexts, firm attributes and innovation outcomes. These three arguments help to devise the hypotheses.

The proposed research model considers firm as the core of NIS and national context conditions it to influence innovation outcomes for economic benefit. The first hypothesis sets out to unravel hierarchical factor structure (latent constructs) of the firm and national context-related factors in manufacturing and services sectors. The second hypothesis focuses on assessing enablers and problems of NIS in manufacturing and services sectors. The third hypothesis aims to explore indirect relationships among dimensions of national contexts, firm attributes and innovation outcomes as indicated in figures 2.4 and 2.5. Evidence presented in the literature review support the proposed hypotheses. Table 2.3 shows a summary of the hypotheses developed for this study.

Table 0.3: Summary of Hypotheses Development

No	Hypotheses	Supporting Literature
$H_{1.0}$:	***There exists a hierarchical factor structure (latent constructs) of the firm and national context-related factors in the observations of firms' innovation activities within NIS.***	Multidimensional concept of NIS, conceived and tested by authors Godinho, Mendonça, and Pereira (2003), Nasierowski and Arcelus (1999), Arundel, Lorenz, Lundvall, and Valeyre (2007), Fagerberg and Srholec (2008), Leiponen and Drejer (2007), Srholec and Verspagen (2008), Chaminade, Intarakumnerd, and Sapprasert (2012), Meuer, Rupietta, and Backes-gellner (2015), Weber and Rohracher (2012) and Wieczorek and Hekkert (2012), provides support for this hypothesis,
$H_{1.1}$:	*There exists a first-order factor structure of the firm and national context-related factors in the observations of firms' innovation activities in manufacturing and services sectors within NIS.*	
$H_{1.2}$:	*There exists a second-order factor structure of the firm and national context-related factors in the observations of firms' innovation activities in manufacturing and services sectors within NIS.*	Sectoral differences between manufacturing and services are supported by Pavitt (1984), Malerba and Orsenigo (1997), Malerba (2002), Dosi et al., (1995), Arundel, Lorenz, Lundvall, and Valeyre (2007), Lundvall (2007), Chaminade et al. (2012), Tien and Berg (1995), Berg, Tien, and Wallace, (2001) and Tien, (2007).
$H_{1.3}$:	*Firm and context related factors within NIS differ between manufacturing and services sectors.*	

'Table 2.3, continued'.

No	Hypotheses	Supporting Literature
$H_{2.0}$:	***The dimensions of NIS regarding firm attributes and their contexts have a significant effect on innovation outcomes as an enabler or as a problem***	Scholarly works that discussed systemic problems (Weber & Rohracher, 2012; Wieczorek & Hekkert, 2012; Lamprinopoulou, Renwick, Klerkx, Hermans, & Roep, 2014; Chaminade, Intarakumnerd, & Sapprasert, 2012) either conceptually or empirically provide support for this hypothesis.
$H_{2.1}$:	*The dimensions of NIS regarding firm attributes and their contexts have a significant effect on innovation outcomes in the manufacturing sector.*	
$H_{2.2}$:	*The dimensions of NIS regarding firm attributes and their contexts have a significant effect on innovation outcomes in the services sector.*	Literature supporting Sectoral differences between manufacturing and service sector is same as hypothesis 1.
$H_{2.3}$:	*There is a difference between manufacturing and services sectors in the direct influence of firm attributes and their contexts on innovation outcomes in NIS.*	
$H_{3.0}$:	***The effect of NIS contextual factors on innovation outcomes is intervened or mediated by firm attributes.***	Studies that attempted to explore interrelationships among dimensions of NIS conceptually or empirically (Nasierowski & Arcelus, 1999; Faber & Hesen, 2004; Fagerberg & Srholec, 2008; Jensen, Johnson, Lorenz, & Lundvall, 2005, 2007; Leiponen & Drejer, 2007; Srholec & Verspagen, 2008; Smith, 2000; Hekkert et al., 2011; Patana et al., 2013; Weber & Rohracher, 2012; Lee & Von Tunzelmann, 2005; Samara et al., 2012; Arundel et al., 2007; Gao & Guan, 2009; Castellacci & Natera, 2013; Jensen et al., 2007; Meuer et al., 2015) form the basis for this hypothesis.
$H_{3.1}$:	*The effect of NIS contextual factors on innovation outcomes is intervened or mediated by firm attributes in the manufacturing sector.*	
$H_{3.2}$:	*The effect of NIS contextual factors on innovation outcomes is intervened or mediated by firm attributes in the services sector.*	
$H_{3.3}$:	*There is a difference between manufacturing and services sectors in the effect of NIS contextual factors on innovation outcomes mediated by firm attributes.*	Literature supporting Sectoral differences between manufacturing and service sector is same as hypothesis 1.

The following chapter discusses the methodology employed to study these hypotheses.

CHAPTER 3: METHODOLOGY

3.1. Introduction

This chapter covers the methodology used in the study in eleven sections. Research paradigm and research methodology are discussed in sections two and three. The fourth and fifth sections covered the research process and research model employed to achieve the aim and objectives of this study respectively. The sixth section is on sampling strategy and data collection techniques that includes sampling, data collection procedures and research instrument used for Malaysian National Innovation Survey for the year 2012. The following sections present data analysis techniques namely descriptive analysis, factor analytic model, statistical analysis to assess first- and second-order construct validity and reliability and structural equation modelling. The chapter also includes the ethical considerations for the study followed by response analysis. The response analysis includes the sample details, socio-economic profile of the respondents, and data screening and preliminary analysis for missing data, outliers, normality, and common method bias evaluation. Finally, the chapter concludes with a summary.

3.2. Research Paradigm

This study seeks to address the research problem, ‘is the current framework of National Innovation System suitable for developing or emerging economies?' The specific research issues are:

- What are the prevalent constituents or dimensions of NIS regarding firm attributes and their contexts in emerging economies? How do these dimensions differ between manufacturing and services sectors?

- What are the enablers and barriers to innovation for firms in NIS of an emerging economy? How do they differ between manufacturing and services sectors?
- What are the relationships among national contextual factors, firm related factors and innovation outcomes?

Research paradigms address different researchers' approaches and perspectives to study (Saeed, 2014). Research paradigm is referred as, 'patterns of beliefs and practices that regulate inquiry within a discipline by providing lenses, frames and processes through which investigation is accomplished' (Weaver & Olson, 2006, p. 460). Also as 'the basic belief systems or worldview that guides the investigator' (Guba & Lincoln, 1994, p. 105), and 'shared understandings of reality' (Rossman & Rallis, 2003, p. 37). In general, research paradigm is a view or approach with which a researcher approaches and investigates the research issue.

Guba (1990) and Shaw (1999) classified main research paradigms that guide social science research as (a) positivism, (b) post-positivism, (c) critical evaluation and (d) constructivist evaluation based on the epistemological, ontological and methodological frameworks. However, as Kazi (2003) stated, any attempt to categorise the contemporary evaluation research perspectives is likely to be contentious. The author indicates that the boundaries that exist between these paradigms are indicative and depend on the perspectives of the researcher. Therefore, only two extreme paradigms underlying social science research as indicated by Easterby-Smith, Thorpe and Lowe (1999) are discussed here to choose the paradigm to guide this study. They are positivism and interpretivism (phenomenology). While Positivism leans towards a deductive approach, interpretivism is towards an inductive approach. Table 3.1 presents the differences found in the two types of research paradigms.

Table 3.1: Summary of the Two Extreme Research Paradigms

Criteria	Positivist Paradigm	Interpretivist Paradigm (Phenomenology)
Epistemology	Objectivism	Constructivism
Nature of Knowledge	Knowledge is based on verified hypotheses.	Knowledge is based on subjective beliefs, values, reasons, and understanding.
Nature of Reality or Belief	The world is external and objective. True reality exists by the unchangeable natural cause-effect laws. Reality can be generalised. Researchers and reality are independent. Science is value-free.	Reality is constructed, interpreted, and experienced by people in their interactions with each other and broader social systems. Human interests drive Science.
Role of Researcher	Uncovers reality focusing on facts, and scientifically explains, describes, and predicts phenomena. Follows deductive approach.	Study social, cultural, and mental phenomena focusing on meaning to reveal why people behave in specific ways. Describes the multiple realities. Follows inductive approach.
Relation to Theory	Tests theories in a controlled setting, empirically supporting or falsifying hypotheses through a process of experimentation.	Social and cultural contexts shape theory.
Methods Used	Quantitative methods. Operationalising concepts so that they can be measured using large samples from which to generalise to the population.	Qualitative methods. Using multiple methods to establish different views of a phenomenon using small samples researched in depth or over time.

Source: Adapted from Easterby-Smith *et al.* (1999), Guba and Lincoln (1994) and

Bryman and Bell (2007)

This study in NIS falls within evolutionary approaches to innovation and considers firms as the core of the NIS. The famous and prominent evolutionary theorists Nelson and Winter (1982, 2002) postulated that organisational routines as analogous to genes, and firms to organisms, with profit the selection criterion in economic competition. According to Outhwaite and Turner (2007, p.16), Nelson and Winter's principal concern is to 'incorporate long-term change and effective understandings of innovation into economics rather than to develop Darwinian analogues'. The authors also insisted on noting that every evolutionary specialism in the social sciences is committed to collecting more and better evidence, with the aim of reducing the evidence-to-conclusion leaps. Popper (1979) challenged the view that knowledge could be based on 'facts' as absolute truths. In line with Popper, Kazi's (2003, p.5) view on scientific knowledge was 'scientific knowledge could not achieve absolute certainty in terms of facts since observation was both theory-laden and value-laden; and, at best, scientific knowledge was probabilistic knowledge. What is known today are an approximation of truth, and such approximations change and develop as progress is made'.

Based on the discussion above on the paradigms, the most suitable paradigm to guide this study is the positivist research paradigm. As Faizan (2015) noted on the positivist paradigm, this research assumes that the truth or knowledge is based on verified hypotheses with the belief that true reality exists by the unchangeable natural cause-effect laws and therefore, the reality is independent of the researcher. This reality can then be generalised. Further, this study integrated different perspectives for hypotheses development and testing to determine the phenomena of NIS in emerging or developed economies and to validate and generalise the proposed perspective. It deducts variables from the existing literature and intends to explore the relationship among them from the evidence or facts gathered. The philosophy within positivism paradigm that guides the study is objectivism as the study aims to explore the objective truth through systematic and scientific method.

3.3. Research Methodology

Research methodology covers the steps that researcher needs to take to investigate research objectives and answer research questions. The research methodology is chosen mainly based on the paradigm through which a researcher investigates an issue. Based on Ishak and Alias (2005), the methodology is a "guideline for solving a problem, with specific components such as phases, tasks, methods, techniques and tools". This guideline is a critical part of any research as it covers the steps necessary to address the research questions and it influences the quality of outcomes. Since the study seeks to unravel objective truth on the measures and relationships among variables through systematic and scientific method, the research design that employs quantitative methods is most suitable. As highlighted by Gray (2004), two common research methodologies enable quantitative research and are analytical surveys and experimental research. Table 3.2 provides the characteristics of these methodologies.

Table 3.2: Methodologies for Quantitative Research

Analytic Surveys	Experimental Research
(i) Involves a deductive approach (ii) Requires identifying the research population (iii) Requires drawing a representative sample from the population (iv) Generates both quantitative and qualitative data (v) Enables generalizability of the results	(i) Reproduces the techniques of the laboratory experiment with highly structured methods (ii) Requires the formulation of initial hypotheses (iii) Requires establishing control variables (iv) Provides accurate quantitative measurement of outcomes (v) Enables generalizability from samples to similar population

Source: Adapted from Gray (2004)

This study is required to uncover variables and test theory through the exploration of the relationship between variables. Therefore, the analytical survey is useful. This study used data from Malaysian National Innovation Survey 2012, which is an analytical survey. Analytical surveys also allow for generalisation of research findings to the population as this approach is highly structured and conducted on a random set of samples. As this study uses the National Innovation Survey 2012 data and requires identifying the right pool of variables, it employed an ex-post facto design guided by theoretical and empirical findings. Kerlinger (1973) succinctly defined ex-post facto research as a:

> *'Systematic empirical inquiry in which the scientist does not have direct control of independent variables because their manifestations have already occurred or because they are inherently not manipulable. Kerlinger further stated that "Inferences about relations among variables are made, without direct intervention, from the concomitant variation of independent and dependent variables'. (p.379)*

However, this is not to infer that ex-post facto design is not a valid research process. Brandon (2011) and Newman and Newman (1994) pointed out that the most effective use of an ex-post facto design is to help identify a small set of variables from a broad set of variables related to the dependent variable for future experimental manipulation. It is essential to take note that this research design has a disadvantage of low internal validity and advantage of better external validity. Low internal validity indicates that there is always a chance that some other difference between groups was the cause of the effect. Better external validity allows understanding complex behaviours that occur in real life and the realistic data is applicable in a practical sense.

3.4. Research Process

The research process is quite typical to all scientific investigations. As indicated by Frankfort-Nachmias and Nachmias (1992), there are seven stages in the research process and are problem definition, hypothesis, research design, measurement, data collection, data analysis, and generalisation. Chapter 1 covers the first stage of the research process, where research gaps and problem are established. Chapter 2 establishes the hypotheses to be investigated while the previous section (3.3) discusses the research design based on the paradigm that suits to investigate the research issues. As this study used National Innovation Survey data, the stages of measurement and data collection are not a part of this study. The data were then analysed in four subsequent steps in the data analysis stage. First, preliminary data analysis was employed to purify the data and to get the overall view of the responses. The second phase involves factor analysis to uncover the measures of NIS. The third and fourth stages involve structural equation modelling to investigate the systemic problems and interrelationships. The generalisation stage involves interpretation of the findings, conferment with the relevant theories and literature and the discussion on the implications of the findings. In summary, this study used five stages of the research processes involving a problem, hypothesis, research design, data analysis, and generalisation.

3.5. The Research Model

This study views that in an emerging or developing country like Malaysia, NIS should not be investigated in the same way as developed economies where institutions and infrastructure are well established. In a market based emerging economies, firms play a role of innovation agents as indicated by Whitley (2007) for growth and development. Therefore, firm attributes that influence innovation outcomes need to be explained in relation to the national contexts. Based on the literature review, this study proposes a structural model (Figure 3.1) with six first-order measures and 21 second-order measures that can explain innovation outcomes and thus strengthen innovation systems in emerging economies like Malaysia.

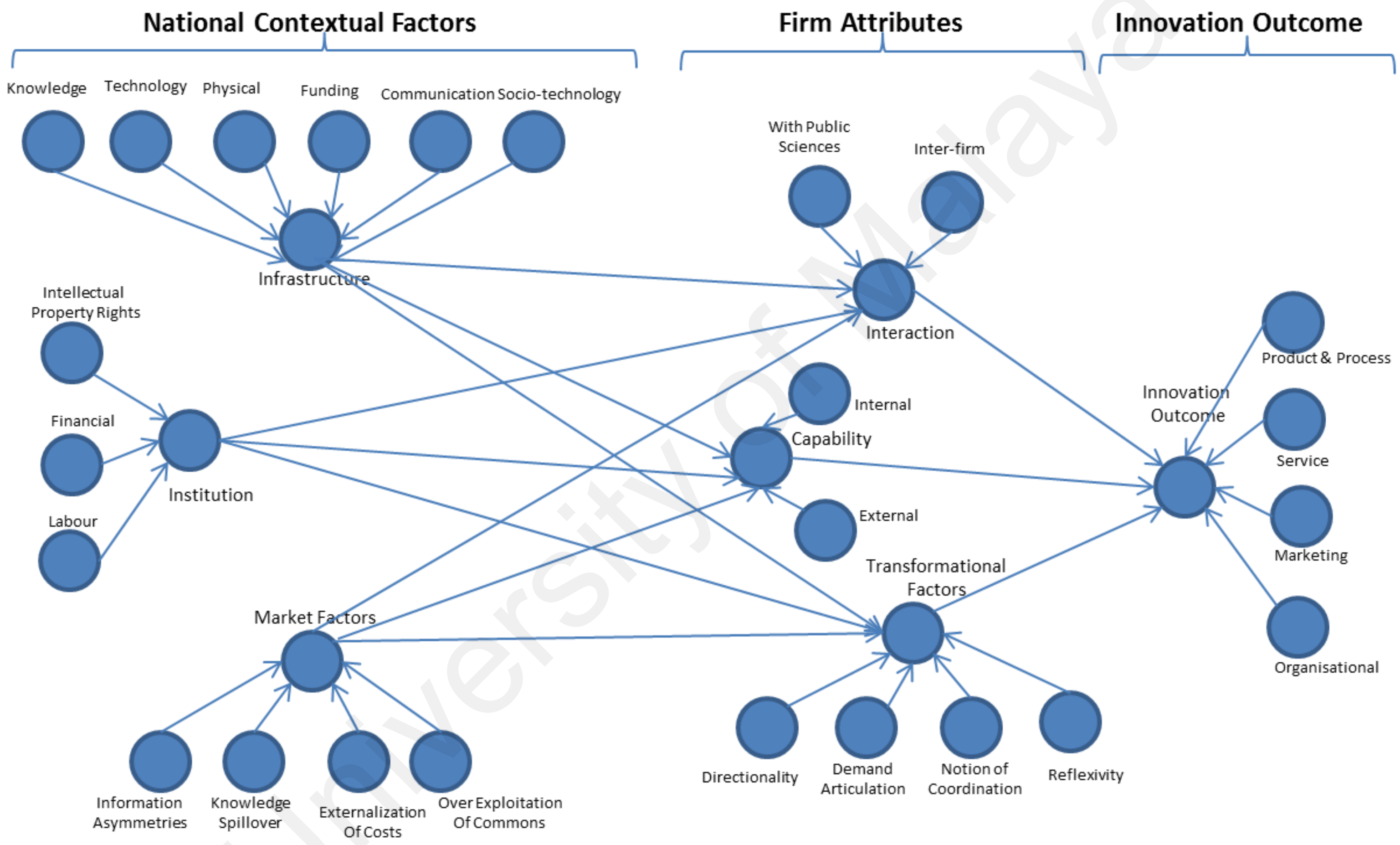

Figure 3.1: Structural Model

3.6. Sampling Strategy and Data Collection Technique

This section of the study covers the survey, sampling technique, unit of analysis and ethical considerations about this study.

3.6.1 Survey

For the analysis, this study used the data from the 2012 National Survey of Innovation, Malaysia, a survey conducted triennially since 1995 except the first one, which covered a five-year period from 1990 to 1994. National Survey of Innovation 2012 is the sixth in the series for Malaysia, covering the period from 2009 to 2011 following Oslo's Manual. The Oslo Manual is a document by 'The Organisation for Economic Co-operation and Development (OECD) on 'The Measurement of Scientific and Technological Activities, Proposed Guidelines for Collecting and Interpreting Technological Innovation Data'. This manual contains guidelines for collecting and using data on firms' innovation. The Oslo Manual's alleged 'activity approach' has been used as the official and preferred method for measuring innovation in many countries including Malaysia (Hong, Oxley & McCann, 2012; MASTIC, 2014). Hong et al. 2012 also highlighted that Oslo Manual is aimed to harmonise national methodologies and collect standardised information on firms' innovation activities since 1992. The manual has seen its third edition to date. As the national innovation survey items are adopted from the Oslo's Manual, the face and content validity are ensured. While face validity refers to a unanimous agreement of a group of qualified individuals who read the instrument on the reflection of the items of a concept, content validity is based on comparison with repeated and systemic literature reviews, in addition to expert judgment (Faizan, 2015).

Each wave of the survey carried out in Malaysia, covering few hundreds to thousands, constitutes a representative sample of the manufacturing firms until the fourth survey. From the fifth survey (which covered the period in between 2005 to 2008) onwards, the survey instrument included services sector together with the manufacturing sector. The sixth survey used for this study covered entire Malaysia for the period 2009-2011 with a focus on manufacturing and services sectors. The scope of the survey includes 13 states and three federal territories in Malaysia and companies in all industries in the manufacturing and services as classified under Malaysian Standard Industrial Classification 2008, version 1.0. It also includes four types of innovation based on the third edition of Oslo Manual (OECD, 2005), i.e. product innovation, process innovation, organisational innovation and marketing innovation.

The Malaysian National Innovation Survey, an important database for economic and policy analysis in Malaysia, is rarely used in economic and policy-related research. Lee (2004) could be pointed out as the early one for using the Malaysian Innovation Survey data (the third survey included the period in between 2000 to 2002) for economic research. However, the study did not attempt to provide a comprehensive understanding of the system. It just carried out an econometric analysis to evaluate the relationship between socio-economic profiles of manufacturing firms with their innovativeness considering only technological innovation. Another research by Chandran, Sundram and Santhidran (2013) looked into innovation system of Malaysia from university-industry linkages perspective. However, authors used data from several sources including the innovation survey data. The study used data descriptively to understand the status of R&D and university-industry linkages for innovation. Therefore, it can be stated that the innovation survey data from Malaysia has not yet been used in studies considering both technological and non-technological innovation, analysing innovation systems as a whole for research purposes and policy implications and with a methodological approach used in this study.

3.6.2 Population and Sampling

The following topics summarise the details of study population and sampling, data collection from Malaysian National Innovation Survey 2012 (MASTIC, 2014), which is the sixth survey for Malaysia.

3.6.2.1. Study Population and Sampling

The population in this study amounts to 631,552 companies including all manufacturing and service sectors as recorded in the Economic Census 2011 Report published by Department of Statistic Malaysia (DOSM). The survey covered firms that fall under the category of the small, medium and large industry for both manufacturing and services sectors. However, the categorisation criteria differ for both the sectors and table 3.3 presents it.

Table 3.3: Criteria of Categorisation of Firms

Category	Manufacturing Sector	Services Sector
Small	Sales turnover between RM 250,000 and less than RM 10 million or full-time employees of 5 to 50.	Sales turnover between RM 200,000 and less than RM 1 million or full-time employees of 5 to 19.
Medium	Sales turnover between RM 10 million and RM 25 million or full-time employees of 51 to 150	Sales turnover between RM 1 million and RM 5 million or full-time employees of 20 to 50
Large	Sales turnover of more than RM 25 million or full-time employees of more than 150	Sales turnover of more than RM 5 million or full-time employees of more than 50

Source: MASTIC (2014)

In line with the recommendations in the Oslo Manual, smaller establishments with less than five employees or less than RM 200,000.00 turnovers are excluded. Even the previous innovation surveys indicated that the percentage of innovation in the smaller establishments was very small.

3.6.2.2. Survey Instrument and Data Collection

As per the National Innovation Survey Report 2012 (MASTIC, 2014), a survey instrument in the form of written questionnaire was used. The questionnaire is attached as Appendix B-1. The questionnaire consisted of 17 sections with 202 items covering general information of the company, product innovation, process innovation, marketing innovation, organisational innovation, on-going or abandoned innovation activities, innovation activities and expenditures, objectives and effects of innovation, government support for innovation, funding, innovation co-operation, sources of information, patents or protection method, hampering factor and finally the National Innovation Model (2007). The report also indicated that the data collection process began in August 2012 and the questionnaires are sent to the respondents in stages. MOSTI also conducted workshops with respondents involving both consultants and MASTIC personnel as facilitators to receive usable and reliable data. The data collections are based on several methods including postal, fax, email, telephone interview, seminar, online and interview.

As recorded in MASTIC (2014), the minimum number of respondents required to represent the whole population was 1,534 based on 95% confidence level or a margin error of 2.5%. The targeted number of respondents was 5,293. The response rate was 38% (N=2,006), which consisted of 84% (N=1,682) usable data and 16% (N=324) non-usable data. Among them the composition of innovative and non-innovative firms are listed below:

Table 3.4: Innovative and Non-Innovative Firms

Sector	Innovative	%	Non - Innovative	%
Manufacturing	445	38	292	58
Services	733	62	212	42
Total	1,178	100	504	10

Source: MASTIC (2014)

This study used only the innovative firms to derive meaningful conclusions in line with the objectives of the study. The database of the innovation survey responses of innovative firms was obtained from the Ministry of Science, Technology and Innovation (MOSTI) with the special permission and the sample consisted of 1178 firms.

3.6.2.3. Sample Size

The sample of innovative firms provided by MOSTI was 1178 (n) that consisted of the subsamples of manufacturing and services sectors with a sample size of 445 and 733 respectively. Based on Urbach and Ahlemann (2010), the minimum recommended sample size ranges from 30 to 100 cases if Partial Least Square (PLS) Structural Equation Modelling (SLM) is employed. However, this study referred a conservative approach of Krejcie and Morgan (1970) to check whether the sample size is sufficient or not to enhance the generalizability of findings.

Krejcie and Morgan (1970) provided a formula and table to determine the required sample size if the target population is finite. The formula used is:

$$S = \frac{X^2NP(1-P)}{d^2(N-1) + X^2P(1-P)}$$

Where:

S = Required Sample size

X = Z value (e.g. 1.96 for 95% confidence level)

N = Population Size

P = Population proportion (expressed as decimal) (assumed to be 0.5 (50%)

d = Degree of accuracy (5%), expressed as a proportion (.05); It is the margin of error

However, if Krejcie & Morgan's (1970) table using sample size formula for the finite population is checked for the population size of more than 75,000 and up to 1,000,000 or more, the estimated sample size is 384. As the population size of this study is 631,552, the appropriate sample size would be 384. Both the subsamples manufacturing and services sectors have a sample size more than 384. Therefore, it is expected for the research to yield best results. The following topic continues with the variables used in the study.

3.7. Variables Measurement

The research model consists of endogenous and exogenous variables. Endogenous variables are variables for which the model determines their variances and exogenous variables are variables for which factors external to the model determines their variance. The structural model used in this study consists of four endogenous variables: one dependent variable – innovation outcomes; and three intermediate variables of firm attributes – capability, interaction and transformational factors. The model also consists of three exogenous variables of national contextual factors namely infrastructure, institution and market factors.

3.7.1. Independent and Intermediate Variables

The indicators of the three intermediate endogenous variables and three exogenous variables are sparingly covered under seven different blocks or sections of the innovation survey in multiple scales (dichotomous nominal and three-point ordinal importance ratings). The sections are namely innovation activities and expenditure, Government support for innovation, funding, innovation cooperation, sources of information for innovation, patent and other protection methods, and factors that hamper innovation. Table 3.5 presents the questions or items covered in the seven sections and the related variables as per the literature in topic 2.4 Dimensions of National Innovation System.

Table 3.5: List of items from National Innovation Survey and the Related Variables of the Study

National Innovation Survey Sections or Blocks and Questions		Related Variable
7.2	*During the three-year period between 2009-2011, did your company engage in the following innovation activities?*	*Capability (dichotomous measures)*
1	In-house R&D (intramural R&D)	
2	Acquisition of R&D (extramural R&D)	
3	Acquisition of machinery, equipment and software	
4	Acquisition of external knowledge	
5	Training	
6	Market introduction of innovations	
7	All forms of design	
8	Preparation for marketing innovation	
9	Preparation for organizational innovation	
9.2	*Did your company receive the following support for innovation from the government during the three-year period between 2009- 2011?*	*Institution (dichotomous measures)*
10	Technical consultancy services (e.g. assistance related to new technologies through technology transfer)	
11	Technical support service (e.g. evaluation of equipment, implementation of productivity improvements, registration of patents)	
12	Duty-free importation of machinery or equipment	
13	Commercialization of R&D Fund	
14	Tax incentive	
15	R&D grant	
16	Innovation grant	

	National Innovation Survey Sections or Blocks and Questions	Related Variable
	'Table 3.5, continued'.	
10.1	*What is your source to finance your innovation activities during the three-year period between 2009-2011?*	*Infrastructure (dichotomous measures)*
17	Own Source for product innovation	
18	Own Source for process innovation	
19	Own Source for organisational innovation	
20	Own Source for marketing innovation	
21	Own Source for R&D	
22	Private Source for product innovation	
23	Private Source for process innovation	
24	Private Source for organisational innovation	
25	Private Source for marketing innovation	
26	Private Source for R&D	
27	Public Source (Government) for product innovation	
28	Public Source (Government) for process innovation	
29	Public Source (Government) for organisational innovation	
30	Public Source (Government) for marketing innovation	
31	Public Source (Government) for R&D	
32	Other Source of product innovation	
33	Other Source for process innovation	
34	Other Source for organisational innovation	
35	Other Source for marketing innovation	
36	Other Source for R&D	
11.2	*Innovation co-operation during the three-year period between 2009-2011*	*Interaction (3-point importance ranting)*
37	Other companies within your company group	
38	Suppliers of equipment, materials, components, services or software	
39	Clients or customers	
40	Competitors and other companies in your industry	
41	Consultants	
42	Commercial laboratories and private R&D institutes	
43	Universities or other higher education institutes	
44	Government or public research institutes	
12.1	*Sources of information for innovation during the three-year period between 2009-2011*	*Infrastructure (3-point importance ranting)*
45	Within the company	
46	Other companies within the company group	
47	Suppliers of equipment, materials, services or software	
48	Clients or customers	
49	Competitors and other companies in your industry	
50	Consultants	
51	Commercial laboratories and private R&D institutes	
52	Universities or other higher education institutes	

	National Innovation Survey Sections or Blocks and Questions	Related Variable
	'Table 3.5, continued'.	
53	Government or public research institutes	
54	Conferences, trade fairs, exhibitions	
55	Scientific journals and trade / technical publications	
56	Professional and industry associations	
57	Technical, industry or service standards	
13.3	*For the period between 2009-2011, please indicate the importance to your company for each of the following methods to protect innovations developed by your company:*	*Institution (3-point importance ranting)*
58	Registration of design	
59	Trademarks	
60	Patents	
61	Copyright	
62	Confidentiality agreements	
63	Secrecy	
64	Complexity of design	
65	Lead-time advantage on competitors	
14.1	*During the three-year period 2009-2011, how important were the following factors for hampering*	*Market Factors, Infrastructure and Transitional Factors (3-point importance ranting)*
66	Cost too high	
67	Lack of funds within the organisation	
68	Lack of finance from sources outside the organisation	
69	Excessive perceived risk	
70	Lack of qualified personnel	
71	Lack of information on technology	
72	Lack of information on markets	
73	Difficulties in finding cooperation partners for innovation	
74	The weakness of intellectual property knowledge and rights	
75	A market dominated by established enterprise	
76	Uncertain demand for innovative goods and services	
77	Innovation is easy to imitate	
	Organisational rigidities within the enterprise:	
78	1. The attitude of personnel towards change	
79	2. The attitude of managers toward change	
80	3. Managerial structure of enterprise	
81	Inability to devote staffs to innovation activities due to production requirement *	
82	Lack of infrastructure (e.g. building) *	
83	Lack of facilities (e.g. Machine, equipment) *	
84	Lack of networking with research institutions (e.g. Universities, SIRIM, PORIM, FRIM, etc.) *	
85	Insufficient flexibilities of regulation or standards *	
86	Limitation of science and technology public policies *	
87	No need to innovate due to earlier innovations *	
88	No need because of lack of demand for innovations *	

*Indicates that these indicators are only available for the manufacturing sector

As the indicators used in the national survey covered the dimensions discussed in the proposed model, it is justified that the data from the survey is suitable to test the proposed model. Factor analytic model (as explained in the data analysis section of this chapter) is used to extract patterns that can explain the dimensions in the model from these 88 items for the manufacturing sector and 80 items for services sector that are related to the variables of interest.

3.7.2 Dependent Variable

Sections from two to five of the questionnaire cover the endogenous dependent variable 'innovation outcomes'. This variable includes the product (goods or services), process, marketing and organisational innovations. The following from the National Innovation Survey 2012 (in table 3.6) is considered to measure the innovation outcomes.

***Table 3.6**: List of items from National Innovation Survey related to Innovation Outcome*

National Innovation Survey Sections or Blocks and Questions		Related Variable
	During the three-year period between 2009-2011, did your company introduce:	*Innovation Outcomes (dichotomous measures)*
2.1	*Product (Goods or Services) Innovation*	
	New or significantly improved products?	
	New or significantly improved services?	
2.2	*Process Innovation*	
	New or significantly improved methods of manufacturing or producing goods or services?	
	New or significantly improved logistics, delivery or distribution methods for your inputs, goods or services?	
	New or significantly improved supporting activities for your processes, such as maintenance systems or operations for purchasing, accounting, or computing?	
2.3	*Marketing Innovation*	
	New or significantly improved methods of product design or packaging?	
	New or significantly improved product distribution/placement?	
	New or significantly, improved product promotion or pricing?	

National Innovation Survey Sections or Blocks and Questions		Related Variable
	'Table 3.6, continued'.	
2.4	*Organisational Innovation* New or significantly improved methods in the firm's business practices? (New or significantly improved knowledge management systems to better use or exchange information, knowledge and skills within your enterprise) New or significantly improved workplace organisation? (A major change to the organisation of work within your enterprise, such as changes in the management structure or integrating different departments or activities) New or significantly improved workplace external relation? (New or significant changes in your relations with other firms or public institutions, such as through alliances, partnerships, outsourcing, or sub-contracting)	

This study used the computed value (using SPSS) of overall innovativeness by combining the product (goods or service), process, marketing and organisational innovations.

3.7.3. Socio-economic Profile Questions

The survey covered the socio-economic profile of the firms in the demography section including respondent's details, company's profile (covering year of establishment, type of ownership, sector, and number of employees). Section 1 covered the industry of the company within the sector it belongs to, the location of the head office and turnover. However, due to privacy concern, the database shared by MOSTI included only the type of ownership, sector, size of the establishment (compiled based on turnover and the number of employees) and industry of the firm.

3.8. Data Analysis Techniques

This study employed (i) descriptive analysis using IBM Statistical Package for the Social Sciences (SPSS) 21 and (ii) hybrid factor analytic model to unravel the first- and second-order dimensions using SPSS 21 followed by factor validation using SmartPLS 3.0. Further, it used (iii) Partial Least Squares Structural Equation Modelling (PLS-SEM) method by SmartPLS 3.0 to test the developed structural models for (a) systemic enablers or problems regarding national contexts and firm attributes and (b) indirect effect of national contextual factors on innovation outcomes through firms' attributes. The descriptive analysis mentioned in (i) is covered later in this chapter under the topic response analysis. The findings of other analyses mentioned in (ii) and (iii) are discussed in detail in chapters 4, 5 and 6. PLS analyses are reported as per Chin (2010) and Hair *et al.* (2013), which are widely accepted by previous studies. The quality of the measures are assessed through validity and reliability tests and reported in chapter 4. The structural models relevant for (iii) mentioned above for both (a) and (b) are assessed and reported in chapters five and six respectively. Table 3.7 shows the summary of research questions, hypotheses, analyses methods, and software used to test them in this study.

Table 3.7: Summary of Research Questions, Hypotheses, Data Analysis Techniques, and Software Used

Research Questions		Research Hypotheses		Data Analysis Techniques	Software
RQ 1.0:	*What are the prevalent dimensions of NIS regarding firm attributes and their contexts? How do these dimensions differ between manufacturing and services sectors?*	$H_{1.0}$:	*There exists a hierarchical factor structure (latent constructs) of the firm and national context related dimensions in the observations of firms' innovation activities within NIS.*		
rq 1.1:	*What are the prevalent dimensions of NIS regarding firm attributes and their contexts in the manufacturing sector?*	$H_{1.1}$:	*There exists a two-level factor structure of the firm and national context related dimensions in the observations of firms' innovation activities in manufacturing sector within NIS.*	*Factor analysis using a hybrid method*	*IBM SPSS ver 21.0*
rq 1.2:	*What are the prevalent dimensions of NIS regarding firm attributes and their contexts in services sector?*	$H_{1.2}$:	*There exists a two-level factor structure of the firm and national context related dimensions in the observations of firms' innovation activities in services sector within NIS.*	*Factor analysis using a hybrid method*	*IBM SPSS ver 21.0*
rq 1.3:	*How do the dimensions of NIS regarding firm attributes and their contexts differ between manufacturing and services sectors?*	$H_{1.3}$:	*Firm and context related dimensions within NIS differ between manufacturing and services sectors.*	*Qualitative comparison of the findings of 1 & 2*	

‘Table 3.7, continued’.

Research Questions			Research Hypotheses	Data Analysis Techniques	Software
RQ 2.0:	*What are the enablers and barriers to innovation for firms in NIS of an emerging economy? How do they differ between manufacturing and services sectors?*	$H_{2.0}$:	*The dimensions of NIS regarding firm attributes and their contexts have a significant effect on innovation outcomes as an enabler or as a problem*		
rq 2.1:	*What are the enablers and barriers to innovation for firms in manufacturing sector within NIS?*	$H_{2.1}$:	*The dimensions of NIS regarding firm attributes and their contexts have a significant effect on innovation outcomes in the manufacturing sector.*	*PLS-SEM by using bootstrapping procedure*	*Smart PLS ver 3.0*
rq 2.2:	*What are the enablers and barriers to innovation for firms in services sector within NIS?*	$H_{2.2}$:	*The dimensions of NIS regarding firm attributes and their contexts have a significant effect on innovation outcomes in the manufacturing sector.*	*PLS-SEM by using bootstrapping procedure*	*Smart PLS ver 3.0*
rq 2.3:	*How do the enablers and barriers to innovation differ between manufacturing and services sector?*	$H_{2.3}$:	*There is a difference between manufacturing and services sectors in the direct influence of firm attributes and their contexts on innovation outcomes in NIS.*	*Qualitative comparison of the findings of 1 & 2*	
RQ 3.0:	*What are the relationships among national contextual factors, firm related factors and innovation outcomes? How do they differ between manufacturing and services sectors?*	$H_{3.0}$:	*The effect of NIS contextual factors on innovation outcomes is intervened or mediated by firm attributes*		

	Research Questions		Research Hypotheses	Data Analysis Techniques	Software
	'Table 3.7, continued'.				
rq 3.1:	*What are the relationships of firm attributes and contextual factors with innovation outcomes in the manufacturing sector?*	$H_{3.1}$:	*The effect of NIS contextual factors on innovation outcomes is intervened or mediated by firm attributes in the manufacturing sector.*	*PLS-SEM by using bootstrapping procedure*	*Smart PLS ver 3.0*
rq 3.2:	*What are the relationships of firm attributes and contextual factors with innovation outcomes in services sector?*	$H_{3.2}$:	*The effect of NIS contextual factors on innovation outcomes is intervened or mediated by firm attributes in the services sector.*	*Qualitative comparison of the findings of 1 & 2*	*Smart PLS ver 3.0*
rq 3.3:	*How do manufacturing and services sector differ in the relationships of firm attributes and contextual factors with innovation outcomes?*	$H_{3.3}$:	*There is a difference between manufacturing and services sectors in the effect of NIS contextual factors on innovation outcomes intervened by firm attributes.*	*Qualitative comparison of the findings of 1 & 2*	

3.8.1. Descriptive Analysis

IBM SPSS 21 is used to describe the samples from both manufacturing and services sectors meaningfully. The samples are described based on the type of ownership, location head office, company size, turnover in the year 2011 and industry of the firm within the sector. Indeed, the descriptive analysis gives the overall picture of the sample composition and characteristics of 445 samples from the manufacturing sector and 733 from services sector considered for this study.

3.8.2. Factor Analytic Model

After the basic descriptive analysis, the first group of hypotheses was tested. Factor analytic model is employed to explore the dimensions or measures of NIS from the items chosen as indicated earlier in this chapter. Factor analytic model is a multivariate statistical tool that draws out a set of typical underlying dimensions called factors. In general, this method condenses and summarises the data. This process enables to derive factors that describe the data in a much smaller number of items than the original individual indicators.

There are two (2) types of factor analytic models and are R-type and Q-type. While R-type groups items by correlating variables, Q-type groups items by computing correlation between the respondents. As indicated by Hair, Anderson, Tatham and Black (1995), R-type factor analysis is suitable for studies that aim to reveal the underlying relationships and groupings between the variables and to distinguish representative items from a large pool of items for inclusion in future analyses. Therefore, this study chose R-type factor analysis as the aim of the study is in line with Hair et al. (1995).

There are two types of commonly used R-type factor analysis and are Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). Based on Kim and Mueller (1978), exploratory factor analysis (EFA) is used when the researcher does not know definitely how many underlying dimensions are there for the given data. Therefore, EFA is used in this study compared to Confirmatory Factor Analysis (CFA) due to the limited empirical studies available in measuring NIS indicating the underlying dimensions. NIS has been previously assessed conceptually and qualitatively for policy purposes. Only a few studies (Srholec & Verspagen, 2008; Chaminade et al., 2012) found to have used quantitative data from Innovation surveys to assess the NIS second-order factors. These studies were meant for different purposes (such as strategies and systemic problems), procedurally driven, did not use a well defined theoretical framework, and showed a considerable difference in the findings. Also, these studies did not attempt to differentiate emerging economies from developed economies. EFA allows for the statistical investigation of the presence of various dimensions of NIS in the sample. Also, as Netemeyer, Bearden, and Sharma (2003) highlighted, EFA provides an opportunity to select and retain the most appropriate items that assess each dimension or element.

More specifically, EFA explores how many factors exist among a set of variables and the degree to which the variables are related to the factors (Field, 2005). Items loading on the same factor specify that these items are measuring the same underlying dimension. This process enables the development of measures of the NIS by choosing items reflecting each underlying characteristic of the system. These measures could also be potentially new but conceptually valid factors explaining NIS for policy purposes. Based on Tinsley and Tinsley (1987), the value of factor analysis is that it provides a meaningful organisational scheme that can be used to achieve a more parsimonious explanation of the variables. In factor analysis, although the results are objective, determining the number of components and assigning conceptual meaning to the components is an exploratory process too. Exploratory factor analysis is in general associated with theory development.

As this study aims to uncover the underlying measures or elements of NIS, it is exploratory, and thus EFA is suitable. To operationalise and interpret EFA, the 'Five-Step Exploratory Factor Analysis Protocol' proposed by Williams, Brown, and Onsman (2012) and as explained by Majumdar and Mitra (2015) is presented below in table 3.8.

Table 3.8: Description of the Steps in Factor Analytic Model

Steps	Description
Step 1: Suitability of data for factor analysis	Suitability of data is checked based on (a) sample size and (b) data type. Several guiding rules of thumb are cited in the literature for sample size. Sufficient sample size is necessary to interpret the data and make conclusions about the validity and generalizability of the results. Hair, Sarstedt, Ringle and Mena (2012) stipulated a minimum sample size of 100 or higher. The data requires being quantitative or interval scale data.
Step 2: Factor extraction technique	Factor extraction is an important step in the factor analysis procedure, which is used to cluster observed variables within the dataset such that a given factor accounts for maximum variance of the variables loading on to it. There are several methods to extract factors or estimators such as Principal components analysis (PCA), principal axis factoring (PAF), image factoring, maximum likelihood, and alpha factoring and canonical, weighted least squares (WLS), generalised least squares and un-weighted least square (ULS) method.
Step 3: Factor extraction.	Factor extraction is the method of identifying the components that best characterise a set of variables. Three-factor extraction methods are frequently used in factor analysis. They are principal-axis factoring (PAF), principal components analysis (PCA), and the maximum likelihood (ML) method. Of the methods, PCA is the most popular (Conway & Huffcutt, 2003). Several criteria need to be satisfied for factor extraction, such as Kaiser Criteria (Eigenvalue > 1), explained cumulative variance, scree plot and parallel analysis.
Step 4: Factor rotation	Factor rotation is employed to achieve simple and theoretically more important factors, as un-rotated factor solutions will not be able to provide the adequate interpretation of the variable under examination. There are two standard rotation techniques: orthogonal rotation and oblique rotation. The most straightforward rotation technique in use is an orthogonal factor rotation, in which axes are maintained in 908 (Hair et al., 2012). Three major orthogonal approaches are quartimax, varimax and equimax. The varimax rotational approach maximises the sum of variances of required loadings of the factor matrix. Compared to other methods, the varimax method has been successfully used to obtain an orthogonal rotation of factors (Hair et al., 2012).

Steps	Description
	'Table 3.8, continued'.
Step 5: Labelling of factors.	Once all variables are investigated for their highest significant loading (0.3 and above) on a factor based on the rotated component matrix, all factors should be labelled for easy interpretation. Variables with higher loadings are considered more important than others.

Source: Compiled based on Majumdar and Mitra (2015), Hair et al. (2012), Conway and Huffcutt (2003), and Dean (2009)

3.8.2.1. Multiple Factor Analysis

The items considered for this study are measured under different blocks or sections of the survey in multiple scales (dichotomous nominal and three-point importance rating ordinal observations). Therefore, combining the items from different sections and employing the factor analysis directly on them is not appropriate. Therefore, this study used Multiple Factor Analysis (MFA) to rectify this issue.

MFA is an extension of PCA created to handle multiple data tables that measure sets of variables collected on the same observation or (in dual-MFA) multiple data tables where the same variables are measured on different sets of observations (Hervé Abdi, Williams, & Valentin, 2013). It is also referred as Multiple Factorial Analysis. As the items considered for this study are measured under seven (7) different blocks or sections of the survey in multiple scales (dichotomous nominal and three-point importance rating ordinal observations) on same observations, MFA would be the appropriate factor analytic method to consider. The scale remains the same within the same section. Herve Abdi and Valentin (2007) explain the goal of MFA is to integrate different groups of variables describing the same observations. Therefore, this method makes these groups of variables comparable first, which is necessary, which is similar to normalisation. Otherwise, the group with the strongest structure would dominate the analysis obtained by combining all variables directly, in other words, dominated by the variables with the largest variance. After this step, all variables that are comparable are concatenated into a data table, which is used for employing PCA. According to the Herve Abdi and Valentin, (2007) and Hervé Abdi et al. (2013), 'MFA proceeds in two steps: First, it computes a PCA of each data table and 'normalises' each data table by dividing all its elements by the first singular value obtained from its PCA. Second, all the normalised data tables are aggregated into a grand data table that is analysed via a (non-normalized) PCA that gives a set of factor scores for the observations and loadings for the variables'.

Furthermore, the study also assumed that the characteristics or attributes of NIS are complex and require to be conceived at different levels. Higher-order factor analysis may be suitable for this purpose.

3.8.2.2. Higher-order Factor Analysis

Higher-order factor analysis extracts factors at different hierarchical levels. As Gray (1997) explains, factors have been conceptualised as groupings of variables that share an acceptable amount of variance, or in other words, variables that are correlated with one another. The higher-order factors explain the relationships among factors at the next lower level in the same way that the first-order factors explain the relationships among manifest variables. It is, therefore, reasonable to expect that the variables in different levels might be hierarchically related to one another.

Gorsuch (1983) stipulated that continuing the process used for the first-order factor analysis on the first-order factors results in the extraction of second-order factors. The author also added that an inter-factor matrix of associations (R, factors by factors) is constructed, and factors are then extracted from it using PCA (or PFA), or another suitable method. The resultant higher-order factor matrix (H, factors by higher-order factors) can then be rotated. However, Gray (1997) noted that the statistical significance of the matrix (Bartlett, 1950) need not be used as a test to determine the number of factors because it will vary according to rotation strategy (Gorsuch, 1983). Gray (1997) also noted that this is not an issue as the utility of statistical significance testing is limited, at best based on Thompson (1994 and 1996). However Gray (1997) also highlighted on the criticism received on using higher-order factor analysis mainly from Nunnally (1978) on the usage of higher-order factor analysis in psychology. The author questioned the parsimony of having different orders of factors when factor analysis itself is partly founded on the principle of parsimony. However, the author indicates that the use of higher-order factor analysis requires more time and effort, but it provides a greater wealth and diversity of information from a given data set. A huge confusion and interchangeable use were also noted between higher-order factor analysis and hierarchical factor analysis. As indicated by Yung, Thissen and McLeod (1999), factors in hierarchical factor models are classified into "layers". The factors in the first layer are the groupings of the related manifest variables, which is similar to that of the first-order factor model for manifest variables in the hierarchical factor model. The next layer of factors in the hierarchical factor model again groups the manifest variables into clusters where each cluster contains at least two clusters of manifest variables that are formed in the previous layer. However, higher-order factor analysis extracts factors at different hierarchical levels.

It seems reasonable to assume that national innovation characteristics may be conceived functioning at different levels of complexity. That is, complex characteristics can be an assembly of progressively less complicated and low levels of activity – each level may have semantic and practical meaning. Therefore, higher-order factor analysis, preferably second-order factor analysis is suitable as it extracts factors at two different hierarchical levels. Furthermore, Thompson (1990) has suggested that elucidating first- and second-order factors from a data set are analogous to looking at a mountain range from a close-up view and again from further away. The dataset involves firms' perspective of the NIS at the micro-level. Therefore, as Thompson (1990) indicated, the second-order factor analysis on this micro-level data offers the ability to have the macroscopic view of NIS in ways, which potentially aid interpretation for national policy agenda. Therefore, this study employed a hybrid method combining MFA and Second-order factor analyses.

3.8.2.3. Hybrid Factor Analytic Method

The hybrid method used in this study employed five (5) steps to uncover measures for NIS combining multiple factor analysis (MFA) and second-order factor analysis and are:

Step 1: Data Scale Assumption

The first step involved in fulfilling the data scale assumption for factor analysis. Based on Suhr, (2005) and various scholarly discussions, the central assumption for measurement scale of the data in factor analysis is interval or ratio scale. The dataset of this study involves categorical variables in dichotomous nominal and three-point importance rating ordinal observations. Therefore, the categorical scores are transformed into numerical scores using 'Optimal Scaling' option in SPSS to qualify the data to be used for factor analysis. The following two (2) steps were adapted from the two (2) steps indicated by Herve Abdi and Valentin (2007) and Hervé Abdi et al. (2013) for MFA.

Step 2: Principal Component Analysis for Individual Groups and Normalisation of Data Set

The second step involved the computation of Principal Component Analysis (PCA) of each data table or section and the first and the largest Eigenvalue obtained from the PCA of each section are noted. This step extracted 81 items out of the 88 items for manufacturing and 71 out of 80 for services sector with the factor loading of at least 0.5 as indicated in table 3.9. The data was then "normalised" by dividing all items of each section by the square root of the first eigenvalue of that particular section obtained from its PCA. Now the normalised datasets are suitable to be merged for further manipulation.

Table 3.9: Outcome of PCA for Individual Groups

No	Title of the Group of items	Manufacturing Sector			Services Sector		
		No of items	No of items with at least a factor loading of 0.5	First and the largest Eigenvalue	No of items	No of items with at least a factor loading of 0.5	First and the largest Eigenvalue
1	Innovation Activities and Expenditure	9	9	4.145	9	9	4.898
2	Government Support for Innovation	7	7	4.126	7	7	2.582
3	Funding	20	17	4.434	20	11	3.791
4	Innovation Cooperation	8	8	5.497	8	8	5.654
5	Sources of Information for Innovation	13	13	8.574	13	13	7.528
6	Patent & Other Protection Methods	8	8	6.413	8	2	4.078
7	Factors that hamper Innovation	23	19	11.116	15	15	7.732
	Total	88	81		80	65	

Step 3: PCA for Aggregated Items

The third step involves merging the data and performing a global analysis to extract factors using PCA. Since there are many variables (81 variables for manufacturing and 65 for services) involved in the study, the variables are aggregated into three groups based on (1) Activities in which firms have direct control, (2) the environment in which firms operate, and (3) misalignments or barriers. This aggregation is also necessary to extract conceptually and practically relevant factors. The first group included the nine (9) items from 'Innovation Activities and Expenditure', eight (8) items from 'Innovation Co-operation' and 13 items from 'Sources of Information for Innovation' for both the sectors. The second group consisted of another three sections including seven items from 'Government Support for Innovation' from both sectors, eight items for manufacturing and two items for services for 'Patents and Other Protection Methods', and 17 items for the manufacturing sector and 11 items for services sector for the section 'Funding'. The third group consisted of 19 items for manufacturing and 15 for services from the section on 'Factors hampering Innovation Activities'. A summary of the factors extracted is presented below in table 3.10.

Table 3.10: PCA Outcome for Aggregated Items

No	Group of items	Manufacturing Sector			Services Sector		
		No of items	**No of factors from PCA**	**No of items with a factor loading of at least 0.5**	**No of items**	**No of factors from PCA**	**No of items with a factor loading of at least 0.5**
1	Firms' activities in which they have control over (activities & expenditure, cooperation, sources of information)	30	6	30	17	4	14
2	The environment in which Firms operate (Government Support, Funding & Intellectual Property Protection Methods	32	7	32	33	9	31
3	Mismatch (Factors hampering innovation activities)	19	5	19	15	4	15
	Total	81	18	81	65	17	60

All the 81 items from the manufacturing sector are grouped into 18 first-order factors. However, only 60 out of the 65 items are grouped into 17 first-order factors. The outcome of the factor analysis is presented below as per the 'Five-Step Exploratory Factor Analysis Protocol' by Williams et al. (2012) discussed earlier.

Sampling Adequacy

It is essential to check the adequacy of the sample size in factor analysis. Inadequate sample size can severely influence the reliability of the factor analysis (Field, 2000). Therefore, the sample is checked for sampling adequacy using several assessments including examination of the anti-image correlation matrix, Bartlett's test of sphericity, and a summary measure devised by Kaiser (1970) known as the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy (MSA). Based on Field (2000), all elements on the diagonal of anti-image correlation matrix should be higher than 0.5 if the sample is adequate (Field 2000). An examination of the anti-image correlation matrix of the three groups of aggregated items showed values higher than 0.5 along the diagonal for all items. Based on Hair et al. (1995), Bartlett's test of sphericity is a statistical test that examines the presence of correlations among the variables. The current analysis of this test showed significant results for the three groups, which indicates that the data is suitable for factor analysis. The KMO Measure of Sampling Adequacy indicates the proportion of common variance in the items that may be attributed to the latent variable (Kaiser, 1970). This analysis showed n KMO MSA value of 0.86, 0.79 and 0.89 for the three groups. Kaiser (1970) suggested 0.5 as a cut-off value for KMO MSA, and the desired value is 0.8 or higher. Though he suggested proceeding with factor analysis with the KMO score of 0.6, this study results showed the desirable value of KMO, thus indicating the appropriateness to proceed with factor analysis. Chapter 4 presents the results of the tests. Basing on the comparison done on the three methods discussed here, Dzuiban and Shirkey (1974) concluded that KMO MSA is the best method for assessing the sampling adequacy for factor analysis. As all the three assessments fulfilled the requirement for sampling adequacy, the data is suitable for factor analysis and further analysis can proceed it.

Factor Extraction

There are many factor extraction methods available as listed by Williams et al. (2012) and are Principal components analysis (PCA), Principal axis factoring (PAF), Maximum likelihood, Unweighted least squares, Generalised least squares, Alpha factoring and Image factoring. Henson and Roberts (2006) indicated that PCA and PAF are used most commonly in the published literature. According to Thompson (2004), the practical differences between the two are often insignificant, mainly when variables have high reliability. PCA is the most commonly used method in which the factors are extracted based on the high correlation between the items. Several authors including Pett, Lackey, and Sullivan (2003) and Kieffer (1999) suggested researchers try both PCA and PAF and compare the results for best fit. In other words, whichever solution produces the best fit and factorial suitability, both intuitively and conceptually, should be used. This study used PCA as it extracted conceptually and practically explainable factors. PCA is also the stipulated method in MFA.

Number of Factors

Several criteria are available to reduce the number of items in the data set to a small number of factors and determine the factors to be retained. Field (2000), and Rietveld and Van Hout (1993) suggested at least three different methods. They are (a) retain only those factors with an eigenvalue larger than 1 (Guttman-Kaiser rule) (b) keep the factors which, in total, account for about 70-80% of the variance, and (3) Make a scree-plot and keep all factors before the breaking point or elbow. The first method is used in this analysis, and all the factors with an eigenvalue of more than one are retained.

Method of Rotation

Methods of rotation facilitate the generation of more interpretable and simplified factors. Williams et al. (2012) indicated that rotation maximises high item loadings and minimises low item loadings, therefore producing a more interpretable and clear solution. Orthogonal rotation and oblique rotation are the two common rotation techniques used in factor analysis. While orthogonal rotation technique produces factor structures that are uncorrelated, oblique rotation produces factors that are correlated (Costello & Osborne, 2005). There are several methods to choose from both rotation options, for example, orthogonal varimax and quartimax or oblique olbimin and promax (Williams et al., 2012). However, Hair et al. (1995) and Kieffer (1999) highlighted that regardless of which rotation method is used, the main objectives are to provide more straightforward interpretation of results and produce a solution that is more parsimonious. Orthogonal varimax rotation produced interpretable results; therefore, it is the method of rotation employed in this study.

Interpretation of Factors

In this step, the researcher examines the variables attributed to a factor and identifies the name or theme to it based on the semantic and practical meaning it implies. Labelling the factors is a subjective process (Pett, Lackey & Sullivan, 2003) and ultimately dependent on the researcher's definition (Henson & Roberts, 2006). However, it is also argued that assigning meaning to the factors is theoretical and inductive (Pett, Lackey & Sullivan, 2003) and it is important for the factors to reflect the theoretical and conceptual intent

(Williams et al., 2012). In general, factor analysis is a search to explore or identify themes or concepts taken together to explain the observations gathered to make sense.

Step 4: Second-Order Factor Analysis

The process used to extract the first-order factor is continued once again with the first-order factors of manufacturing and services sectors separately to extract the second-order factors as stipulated by Gorsuch (1983). The author also added that an inter-factor matrix of associations (R, factors by factors) is constructed, and factors are then extracted from it using PCA (or PFA), or another suitable method. The resultant higher-order factor matrix (H, factors by higher-order factors) can then be rotated. As indicated earlier, different extraction techniques and rotation methods were tried to choose the outcomes with conceptual as well as practical relevance. PCA was eventually employed here.

Step 5: Interpretation of Second-Order Factors

In step 5, the first-order factors attributed to second-order factors were scrutinised and identified the name or theme with the theoretical and conceptual intent.

3.8.3. Construct Validity of Factors

The factors extracted are checked for construct validity in the SmartPLS 3.0 software. Construct validity is meant to check whether the measures projected the construct. Based on Becker, Klein and Wetzels (2012), a higher (or second)-order construct is a general concept and either represented (reflective) or constituted (formative) by its dimensions (lower (or first)-order constructs). Ringle, Sarstedt and Straub (2012) and Jarvis, MacKenzie and Podsakoff (2003) distinguished four types of second-order latent constructs or variables namely, reflective-reflective type, reflective-formative type, formative-reflective type and formative- formative type. Here the first-order factors are reflective constructs as the indicators of those reflect the construct. However, at the second level, the first-order constructs form a general concept, which follows Chin (1998)'s explanation of reflective-formative type. Based on the author, in the reflective-formative type, the lower-order constructs are reflectively measured constructs that do not share a common cause but instead form a general concept that fully mediates the influence on subsequent endogenous variables. Becker et al. (2012) recommend reflective-formative hierarchical latent variables with inner path weighting scheme. Based on the authors, this produces less biased, and therefore, more precise parameter estimates and a more reliable higher-order construct score. The reflective type was also not considered at the second level because Lee and Cadogan (2013) argued that higher-order reflective constructs are, at worst, misleading, and at best meaningless. Based on Becker et al. (2012) there exist three methods to develop higher-order constructs as proposed in the literature. They are the repeated indicator approach (Lohmoller, 1989; Wold, 1982), the sequential latent variable score method or two-stage approach (Ringle et al., 2012; Wetzels, Odekerken-Schroder & van Oppen, 2009), and the hybrid approach (Wilson & Henseler, 2007). However, Becker et al. (2012) highlighted that the repeated indicator approach is more suitable compared to other two approaches due to its ability to estimate both levels of constructs (first and second-order) simultaneously instead of estimating them separately. Thus, it takes the whole network, not only the lower level or the higher-level model into account, thereby avoiding interpretational confounding. Therefore, this study employed 'repeated indicator approach'. A higher-order latent variable can be constructed by specifying a latent variable that represents all the manifest variables of the underlying lower-order latent variables in the repeated indicator approach (Lohmoller, 1989; Noonan and Wold, 1983; Wold, 1982). The constructs are modelled for each second-order hierarchical latent variable model with its first-order constructs that form the second-order construct, the first-order factors as exogenous latent variables having reflective indicators, and one final endogenous latent variable with reflective indicators. The appropriateness of the first-order reflective constructs is checked first. Based on Becker et al. (2012) and Wong (2013), conceptual properties of the lower-order constructs (reflective constructs) were reported with indicator loadings and their significance, Average Variance Extracted (AVE), composite reliability and discriminant validity, which is followed by the evaluation of the second-order constructs. The evaluation of the measurements (constructs) regarding reliability and validity are discussed in the following section.

It is important to establish the reliability and validity of the latent variables to complete the examination of the structural model. Reliability measure checks whether the instrument measures what it purports to measure. Reliability refers to the accuracy and precision of a measurement procedure (Thorndike, Cunningham, Thorndike, & Hagen, 1991). "Cronbach's alpha" is used to measure internal consistency reliability in social science research but it tends to provide a conservative measurement in PLS-SEM. Prior literature has suggested the use of "Composite Reliability" as a replacement (Bagozzi and Yi, 1988; Hair et al., 2012; Wong, 2013). However, validity refers to the extent to which an indicator measures what it is supposed to measure (Saunders et al., 2007). Based on Faizan (2015), validity is achieved when the empirical data set adequately supports the research objectives and the theoretical hypotheses.

3.8.3.1. Construct Validity of First-Order Factors

The appropriateness regarding reliability and validity of the first-order reflective constructs was checked first reliability to ensure the construct validity. Based on Becker et al. (2012) and Wong (2013), conceptual properties of the lower-order constructs (reflective constructs) were reported with evaluation criteria in table 3.11.

Table 3.11: Evaluation of Reflective Measures

Evaluation Type	Criterion	Accepted Indicator Measurements
Reliability Reliability refers to the accuracy and precision of a measurement procedure (Thorndike, Cunningham, Thorndike, & Hagen, 1991).		
Indicator Reliability When assessing indicators' reliability, the researcher is evaluating the extent to which a variable or a set of variables is consistent with what it intends to measure (Urbach & Ahlemann, 2010).	• *Outer loadings*	Square each of the outer loadings to find the indicator reliability value. 0.70 or higher is preferred. If it is exploratory research, 0.4 or higher is acceptable. (Hulland, 1999)
Internal Consistency Reliability This evaluation looks into whether all the items within a particular scale measure the same thing or not and the relationship with other latent variables (strong relationships are not advised). Reliability is an essential condition for achieving validity of a measure (Churchill, 1979).	• *Composite Reliability* Traditionally, "Cronbach's alpha" is used to measure internal consistency reliability in social science research but it tends to provide a conservative measurement in PLS-SEM. Prior literature has suggested the use of "Composite Reliability" as a replacement (Bagozzi and Yi, 1988; Hair et al., 2012).	Internal consistency reliability is considered satisfactory when the value is at least 0.7 in the early stage and values above 0.8 or 0.9 in more advanced stages of research (Nunnally & Bernstein, 1994). If it is exploratory research, 0.6 or higher is acceptable. (Bagozzi and Yi, 1988).
Validity Validity refers to the extent to which an indicator measures what it is supposed to measure (Saunders et al., 2007)		
Convergent validity It involves the degree to which individual items reflect a construct converging in comparison to items measuring different constructs (Urbach & Ahlemann, 2010).	• *Average Variance Extracted (AVE)*	AVE values higher than the acceptable threshold of 0.5 confirms convergent validity. AVE scores above 0.50 indicate strong convergent validity, as this means that the stipulated indicators (Chin & Newsted 1999) explain more than 50 percent of the variation in a particular construct.

Evaluation Type	Criterion	Accepted Indicator Measurements
'Table 3.11, continued.'		
Discriminant validity Discriminant validity is used to differentiate measures of a construct from one another. In contrast with convergent validity, discriminant validity tests whether the items unintentionally measure something else or not (Urbach & Ahlemann, 2010).	• *Cross loading*	
	Cross-loading is obtained by correlating each latent variable's component scores with all of the other items (Chin, 1998).	Item's loading of each indicator is highest for its designated construct (Chin, 1998).
	• *Fornell and Larcker Criterion*	
	Fornell and Larcker (1981) suggest that the square root of AVE in each latent variable can be used to establish discriminant validity	The square root of the AVE of the construct should be higher than the correlations between the construct and other constructs (Fornell and Larcker, 1981)

Source: Compiled from Hashim (2012), Wong (2013), and Faizan (2015)

3.8.3.2. Construct Validity of Second-Order Factors

The second-order dimensions of this study are formative. The formative indicators can have positive, negative, or even no correlations among each other (Haenlein & Kaplan, 2004; Petter et al., 2007). Therefore, Wong (2013) suggests that there is no need to report indicator reliability, internal consistency reliability, and discriminant validity if a formative measurement scale is used. Because outer loadings, composite reliability, and the square root of average variance extracted (AVE) are meaningless for a latent variable made up of uncorrelated measures. Instead, the author also suggested using outer weight (not outer loadings), convergent validity, and collinearity indicators to evaluate the formative indicators. All the constructs (both first-order and second-order) established were checked for validity by establishing a model for each connecting them to innovation outcomes as suggested by Wong (2013). The models of constructs were built adequately in the SmartPLS software, and essential statistics were estimated by running a PLS algorithm (2000 maximum iteration). Conceptual properties of the second-order constructs (formative constructs) or measurement model were reported with indicator weights, the significance of weights, multicollinearity of indicators (Variance Inflation Factor (VIF) and Tolerance) as suggested by Cenfetelli and Bassellier (2009) and Hair et al. (2012) in table 3.12.

Table 3.12: Evaluation of Formative Measures

Criterion	**Accepted Indicator Measurements**
Outer model weight and significance	The weight of a particular indicator is expected to be significant (with t-value of <1.96). However, Wong (2013) suggests not removing the indicator if it is theoretically relevant and the loading of the indicator is significant.
Convergent validity	When the correlation (path coefficient) between the latent variables is 0.80 or higher in a 'redundancy analysis', convergent validity is established (Hair et al., 2013).
Collinearity of Indicators • Variance Inflation Factor (VIF) • Tolerance	The rule of thumb to avoid the collinearity problem is to have a VIF of 5 or lower (the Tolerance level of 0.2 or higher).

Source: Compiled from Wong (2013)

3.8.4. PLS Based Structural Equation Modelling (SEM) Approach

This study used structural equation model (SEM) to examine (i) systemic enablers and problems of innovation outcomes and (ii) influence of national contextual factors on NIS performance regarding innovation outcomes through firms that are the core of the NIS. The principal objective of the items mentioned above was to understand the relationships among the dimensions or measures of NIS. The dimensions of NIS as indicated in chapter 3 are hypothetical constructs or latent variables that cannot be observed directly but can only be measured by multiple items that represent or reflect the variable. Based on Savalei and Bentler (2007), regression analysis needs to be avoided with latent variables as it treats the variables as the combined scales of their respective dimensions, thus losing any information about the possible differential performance of some dimensions of a given construct over others. Therefore, this study chose SEM as this has been considered as a powerful second-generation multivariate technique for examining causal relationships using a combination of factor analysis and regression, which allows the researcher to estimate relationships among observed and latent variables and between latent variables simultaneously (Hair, Hult, Ringle, & Sarstedt, 2013).

The two approaches to performing SEM are component-based approaches such as partial least square (PLS-SEM) and a co-variance-based approach (CBSEM) (Hair et al., 2013). These two approaches differ regarding their underlying statistical assumptions and the nature of fit statistics they produce. Table 3.13 provides a comparison between PLS-SEM and CB-SEM.

Based on Saeed (2014), PLS-SEM is known as an alternative method to CB-SEM, but its advantages over CB-SEM cannot be disregarded. Hair, Ringle and Sarstedt (2011) indicated that PLS-SEM is not only an alternative to CB-SEM but also a complementary modelling approach to SEM. The authors also added that if PLS-SEM is used appropriately, it could be a silver bullet in many research situations. As Saeed (2014) pointed out PLS-SEM is advised when the sample size is small, samples are not normally distributed, the research model consists of formative constructs, or there is little literature on the structural model or measurement model of constructs to develop theories.

Table 3.13: The key characteristics of CB-SEM and PLS-SEM

Criteria	PLS-SEM	CB-SEM
Objective	Prediction-oriented	Parameter-oriented
Approach	Variance-based	Covariance-based
Assumption	Predictor specification (non-parametric)	Typically, multivariate normal distribution and independent observation (parametric)
Parameter Estimates	Consistent as indicators and sample size increase	Consistent
Latent Variable Scores	Explicitly estimated	Indeterminate
The epistemic relationship between latent variables (LV) and its measures	Can be modelled in either formative and reflective mode	Typically only with reflective indicators.
Implications	Optimal for prediction accuracy	Optimal for parameter accuracy
Model complexity	Large complexity	Small to moderate complexity
Sample Size	Power analysis based on the portion of the model with the largest number of the predictor. Minimal recommendation range from 30-100 cases.	Ideally based on power analysis of specific model - minimal recommendation range from 200 to 800
Type of Optimization	Locally iterative	Globally iterative
Estimation method	The algorithm is based on Ordinary Least Squares (OLS) regression	Uses Maximum Likelihood (ML)
Significance tests	Only using simulations: restricted validity	Available
Availability of global Goodness of Fit (GoF)	Are currently being developed and discussed	Established GoF metric

Source: Urbach and Ahlemann (2010) and Saeed (2014)

PLS-SEM is chosen compared to CB-SEM for this study for the second and third group of hypotheses based on the following requirements:

- This study developed measurement model for NIS regarding national contextual factors and firm-related factors to address the NIS performance regarding innovation outcomes. However, there is little prior knowledge on measurement or structural models in this area. The study's focus is exploration than confirmation.

As Hair et al. (2013) indicated, when there are few studies and little prior knowledge on the measurement model and structural model, and the emphasis of the study is on exploration than confirmation, PLS-SEM is a more appropriate approach.

- This study uses both reflective and formative constructs in the model. Based on Vinzi, Chin, Henseler, and Wang (2010), CB-SEM can be used when the model has only reflective constructs, while PLS-SEM can be used for both reflective and formative constructs.
- This structural model of the study is to examine the effect of national contextual factors and firm-related factors on innovation outcomes to explain and predict to what extent these factors can enhance innovation performance of the country. PLS-SEM is a variance-based SEM (VB-SEM) approach, and its algorithm minimises the error term (the residual variance) of the endogenous variables. Therefore, it is appropriate when the aim of the research is the development of theories and maximising the explanation of variance (Hair et al., 2011). Saeed (2014) remarks that PLS-SEM is a right choice for predicting endogenous variables in a structural model.
- This study uses secondary data from Malaysian National Innovation Survey. Therefore, there are possibilities for measurement items to deviate from a normal distribution. The advantage of using PLS-SEM is, it does not assume the sample distributions (Chin, 1995); and it uses a non-parametric distributional free approach which can be used for non-normal data distributions as well (Chin, 2010).

PLS-SEM requires two major steps. The measurement model requires evaluation first followed by a structural model. The measurement model assessment was to evaluate the absolute and relative relevance of constructs, and it is discussed in the previous section. The structural model is assessed to examine the direct and indirect effect of national contextual factors on innovation outcomes through firm related factors. The PLS-SEM method using PLS algorithm and bootstrapping with 2000 samples was employed (Ringle, Wende, & Will, 2005) using SmartPLS 3.0. Hair *et al.* (2013) suggested five steps for PLS-SEM structural model assessment and are namely collinearity issue assessment, assessment of significance and relevance of paths, coefficient of determination (R^2) assessment, assessment of the effect size (f^2), and assessment of the predictive relevance (Q^2) as indicated below in figure 3.2.

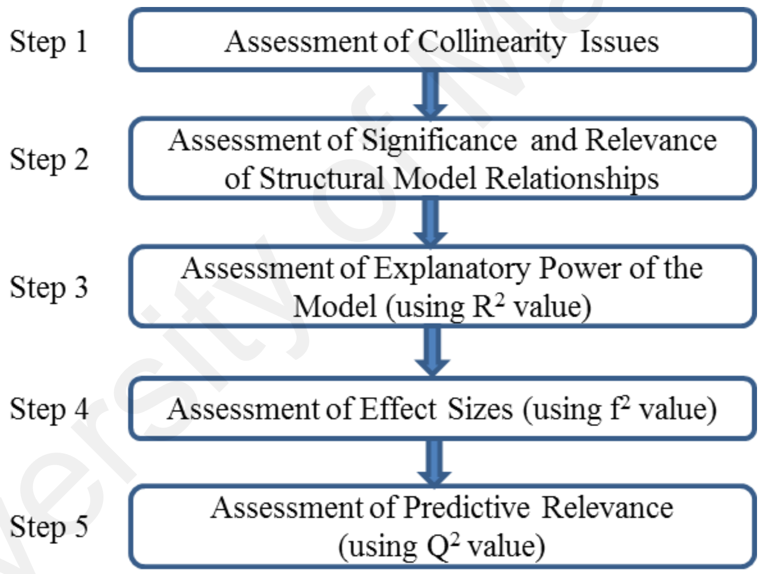

Figure 3.2: PLS-SEM Structural Model Assessment

Source: Hair et al. (2013, p. 169)

Besides, the importance of the dimensions in the model is examined by computing the f^2 effect size. Finally, by implementing blindfolding technique, the Stone-Geisser's Q^2 effect size (Geisser, 1974; Stone, 1974) and q^2 effect size are calculated to assess the predictive accuracy and relative impact of the predictive relevance of the model.

3.9. Ethical Considerations

Ethical consideration is paramount whether it is primary or secondary data to ensure the maximum benefit of the research while minimising the risk of actual or potential harm. Based on ESRC (2015), ethical procedures should seek to protect, as far as possible, all groups involved in research including participants, researchers and research teams, research officers, non-academic collaborative researchers (and organisations) and funders, throughout the lifecycle of the research.

Ethical concerns start from the initial design of the study and continue until the reporting of results, which should ensure transparency, publicness and replicability. However, when secondary data is considered, it is collected as part of the different research, with purposes other than those of the present study. This study uses official statistical data of Malaysian National Innovation Survey 2012 in a quantitative format.

As indicated earlier, the maximum benefit of the secondary data is only realised if risks are minimised, notably regarding re-identification of individuals and disclosure of sensitive information. Based on the Research Ethics Guidebook for Social Scientists, use of secondary data must meet some critical ethical conditions: data must be de-identified before releasing to the researcher; outcomes of the analysis must not allow re-identifying participants, and use of the data must not result in any damage or distress. The database released by MOSTI has ensured that direct or indirect identification of the respondent is not possible. Name of the respondent is removed to avoid direct identification of the respondent. Numbers of employees, year of commencement of the establishment, the exact location of the establishment were also not disclosed to avoid indirect identification of the respondent. It is agreed to a non-disclosure agreement that the data will be used only for the thesis and scholarly publications in a responsible manner.

3.10. Response Analysis

3.10.1. General Survey Responses

3.10.1.1. Sample

The data obtained from the Ministry of Science, Technology and Innovation (MOSTI) with the special permission consisted of a sample of 1178 firms comprising of firms from manufacturing and services sectors as indicated in table 3.14.

Table 3.14: Sample Size of Manufacturing and Services Sectors

Sector	Innovative	%
Manufacturing	445	38
Services	733	62
Total	1,178	100

Source: (MASTIC, 2014)

As explained earlier in the chapter, both the samples are more than 384, which is an estimated sample size based on the finite population using Krejcie and Morgan's (1970) table. Therefore, the sample is expected to yield best results in general.

3.10.1.2. Socio-economic Profile

The socio-economic profile of manufacturing and services sectors are presented in the subsections below.

Manufacturing Sector

Descriptive statistics of the 445 manufacturing firms considered for this study are presented in table 3.15.

Table 3.15: Socio-economic Profile of Manufacturing Firms (n= 445)

Firm Characteristics	Number of firms	% number of firms
Type of Ownership		
Partnership	23	5.2
Private Limited (Sdn.Bhd.)	314	70.6
Public Limited (Bhd)	49	11.0
Sole Proprietorship	59	13.3
Location of the Head office		
Malaysia	380	85.5
Outside Malaysia	65	14.6
Company Size		
Large	187	42.0
Medium	147	33.0
Small	111	24.9
Turnover in the year 2011 (Ringgit Malaysia)		
250,000 - 1,000,000	76	17.1
1,000,001 - 5,000,000	22	4.9
5,000,001 - 10,000,000	13	2.9
10,000,001 - 15,000,000	83	18.7
15,000,001 - 20,000,000	39	8.8
20,000,001 - 25,000,000	25	5.6
25,000,001 - 30,000,000	174	39.1
> 30,000,000	13	2.9
The industry of the Sector		
Computer, Electronic and Optical Products	110	24.7
Food and Beverages	64	14.4
Machinery and Equipment (n.e.c.)	36	8.1
Rubber and Plastics Products	33	7.4
Electrical Equipment	30	6.7
Wood and Products of Wood and Cork, except Furniture; Manufacture of Articles of Straw and Plaiting Materials	23	5.2
Fabricated Metal Products, except Machinery and Equipment	20	4.5
Basic Pharmaceutical Products and Pharmaceutical Preparations	20	4.5

Firm Characteristics	Number of firms	% number of firms
'Table 3.15, continued'.		
Other Manufacturing	19	4.3
Chemicals and Chemical Products	15	3.4
Wearing Apparel	13	2.9
Furniture	12	2.7
Textiles	11	2.5
Paper and Paper Products	9	2.0
Motor Vehicles, Trailers and Semitrailers	8	1.8
Repair and Installation of Machinery and Equipment	7	1.6
Leather and Related Products	6	1.3
Other Non-metallic Mineral Products	4	0.9
Printing and Reproduction of Recorded Media	3	0.7
Basic Metals	2	0.4

Note: The descriptions of size studied in the manufacturing sector are: 'large' representing firms with sales turnover of more than RM 25 million or full-time employees of more than 150; 'medium' representing firms with sales turnover between RM 10 million and RM 25 million or full-time employees of 51 to 150; and 'small' representing firms with sales turnover between RM 250000 and less than RM 10 million or full-time employees of 5 to 50.

The sample of firms considered for this study from the manufacturing sector of Malaysia consisted of firms mainly owned by Private Sector (70.6%) followed by Sole Proprietorship (13.3%) and Public ownership (11.0%). A minority of the firms (5.2%) are in Partnership. Mostly the head office of these firms is in Malaysia (85.5%), and only 14.6% of the firms have their head office out of Malaysia. This study looked into the size of the firms in terms of large, medium and small.

The firms studied here are mostly large firms (42.0%) followed by medium (33.0%) and small (24.9%). A majority of the firms earned at the high end between RM 25 million to RM 30 million (39.1%) followed by two distinct groups between RM 10 million to RM 15 million (18.7%) and between RM 0.25 million to RM 1.00 million (17.1%) considering the turnover for the year 2011. The minority falls into two categories and are between RM 5.0 million to RM 10 million (2.9%) and more than RM 30 million (2.9%).

The top five industry categories constitute about 61.3% of the firms, which is more than half of the sample. The top five industries are Computer, Electronic and Optical Products (24.7%), Food and Beverages (14.4%), Machinery and Equipment (8.1%), Rubber and Plastics Products (7.4%) and Electrical Equipment (6.7%). In summary, a typical innovative firm in the manufacturing sector is owned by private sector, large with the turnover between RM 25 million to RM 30 million and the head office located in Malaysia and mainly from the industry category of Computer, Electronic and Optical Products.

Services Sector

Table 3.16 presents descriptive statistics of 733 services related firms considered for this study.

Table 3.16: Socio-economic Profile of Firms from Services Sector (n= 733)

Firm Characteristics	Number of firms	% number of firms
Type of Ownership		
Partnership	45	6.1
Private Limited (Sdn.Bhd.)	435	59.3
Public Limited (Bhd)	34	4.6
Sole Proprietorship	219	29.9
Location of the Head office		
Malaysia	733	100.0
Outside Malaysia	0	0.0
Company Size		
Large	121	16.5
Medium	273	37.2
Small	339	46.2
Turnover in the year 2011 (Ringgit Malaysia)		
200,001 - 500,000	193	26.3
500,001 - 1,000,000	146	19.9
1,000,001 - 2,500,000	138	18.8
2,500,001 - 3,500,000	84	11.5
3,500,001 - 5,000,000	51	7.0
5,000,001 - 6,500,000	103	14.1
> 6,500,000	18	2.5

Firm Characteristics	Number of firms	% number of firms
'Table 3.16, continued'.		
The industry of the Sector		
Travel and Tour	265	36.2
Professional, scientific and technical activities	101	13.8
Construction	79	10.8
Education	62	8.5
Information and communication	56	7.6
Arts, entertainment and recreation	39	5.3
Human Health and social work activities	32	4.4
Water supply: sewage, waste management and remedial	21	2.9
Transportation and storage	19	2.6
Wholesale and retail trade; repair of a motor vehicle	16	2.2
Accommodation and Food Service Activities	13	1.8
Administrative and support service activities	11	1.5
Financial and Insurance / takaful activities	4	0.5
Electricity, gas, steam and air conditioning supply	4	0.5
Activities of Households as employers	3	0.4
Real estate Activities	2	0.3
Public Administration and Defence; compulsory social	2	0.3
Printing and reproduction of recorded media	2	0.3
Activities of extraterritorial organisations and b	2	0.3

Note: The descriptions of size studied in the services sector are: 'large' representing firms with sales turnover of more than RM 5 million or full-time employees of more than 50; 'medium' representing firms with sales turnover between RM 1 million and RM 5 million or full-time employees of 20 to 50; and 'small' representing firms with sales turnover between RM 200000 and less than RM 1 million or full-time employees of 5 to 19.

The sample of firms considered for this study from the services sector of Malaysia consisted of firms mainly owned by Private Sector (59.3%) followed by Sole Proprietorship (29.9%) and Partnership (6.1%). A minority of the firms (4.6%) are from Public Ownership. All the firms considered for this study had the head office in Malaysia (100.0%). Looking at the size of the firms, most of the firms are small (46.2%) followed by medium (37.2%) and the minority is large (16.5%). A majority of the firms earned at the lower end between RM 200 001 to RM 500 000 (26.3%) followed by groups between RM 500 001 to RM 1 000 000 (19.9%) and between RM 1 000 001 to RM 2 500 000 (18.8%) considering their turnover for the year 2011. The minority falls at the highest range, which is more than RM 6.5 million (2.5%).

The top five industry categories constitute about 77% of the firms, which is almost three-quarter of the sample. The top five industries are Travel and Tour (36.2%); Professional, scientific and technical activities (13.8%); Construction (10.8%); Education (8.5%); and Information and communication (7.6%). In summary, a typical innovative firm in the services sector is owned by private sector, small with the turnover between RM 200000 to RM 500000 and the head office located in Malaysia and mainly from the industry category of Travel and Tour.

3.10.2. Data Screening and Preliminary Analysis

The data is screened to ensure the accuracy of data entry. All relevant variables for this study across samples are screened for suitability. Based on Tabachnick and Fidell (2001), an examination of the data ranges, measures of central tendency, variability in each item are done and established that the data resided within the valid parameters of a sample. The data are also assessed for psychometric assumptions to fulfil the appropriateness of using PLS path modelling in this study. The assessment included treatment of missing data, the normality of data distribution and common method bias. Fulfilling these assumptions is critical as they may have a direct influence on employing as well as on the outcome of the data analysis techniques.

3.10.2.1. Missing data

Examining the dataset for missing values is necessary before the data analysis. Any variable with less than five percent of missing values can be ignored (Tabachnick & Fidell, 2001). However, Cohen and Cohen (1983) indicated that up to 10 percentage of missing values in a dataset was unlikely to be problematic in the interpretation of the results from studies. As for this study is concerned, there were no missing data in both manufacturing (88 items) and services (80 items) datasets of the National Survey of Innovation, Malaysia.

3.10.2.2. Outliers

The data is also checked for potential outliers that may have undue influence on the statistical analyses to be performed on the data. The scores of all the variables to be analysed are transformed into standardised z-scores to examine the outliers; The z-scores are evaluated as per the criteria suggested by Tabachnick and Fidell (2001). Based on the authors, the scores outside the range of -3.29 and +3.29 are considered the potential outliers, and they may have undue influence on the distribution of the data. Out of the 88 items considered for the analysis in the manufacturing dataset, eight (8) items (F-PuS1, F-PuS3, F-PuS4, F-OtS1, F-OtS2, F-OtS3, F-OtS4, F-OtS5) had outliers, which ranged between one (1) to five (5) percent of the measurements. Here the item label 'F-PuS' represents 'funding from public sources', and 'F-OtS' represents 'funding from other sources'. The numbers associated with these labels indicate the number of the item within a particular label. As there were very few outliers in these items, they can be treated by either deleting them or indicating them as missing values. The outliers are treated by assigning any value higher than 3.29 or less than -3.29 to be a missing value as there were less than 5% in the outlier category for each item.

There are four outliers out of the 81 items and are F-PuS3, F-OtS1, F-OtS3, and F-OtS4. For F-PuS3 and F-OtS4, only four percent of the data fall into the outlier category (either more than 3.39 or less than -3.29). Here the outliers are treated by assigning them as missing values since there are only less than 5% in the outlier category. However, F-OtS1 and F-OtS3 had 19.2% of data falling into the outlier category. Assigning them as missing values will result in an item with more than 10% missing values, which may create a problem in factor extraction and other analysis. Therefore, these two items are discarded from the data set, which leaves with 88 items from the manufacturing sector and 78 items from Services sector suitable for analysis.

3.10.2.3. Data Normality

The two statistical analyses used to examine the normality of the data and are 1) Shapiro-Wilk test, and 2) skewness and kurtosis. Kline (2005) indicated that kurtosis scores outside of +/-2 and skewness rating outside +/-1 have the potential to restrict data analysis and subsequent interpretation of results. The variables with significant values in Shapiro-Wilk test are not normally distributed. The results of both the tests are presented in Appendix B-2. It can be noted from the results that (1) some variables showed the skewness and kurtoses values above the recommended thresholds and (2) all the variables have significant values of 0.00 from Shapiro-Wilk test. Therefore, the results confirm that the distribution of the data is not normal.

Based on Tabachnick and Fidell (2001), when factor analysis is used to describe and summarise the relationship between a broad set of variables as in this study, assumptions related to the distribution of variables are not imposed. Therefore, employing factor analysis for this data is acceptable. Usual multivariate data analysis techniques such as regression analysis and SEM require normally distributed data. However, Hair et al. (1995) indicated that an alternative technique could be employed when normality assumption is violated in the data to be analysed. Furthermore, Hair et al. (2013) recommended strongly PLS path modelling when the data to be analysed deviates from normality assumption.

3.10.2.4. Common Method Variance

Common method variance or bias occurs in a data that are self-reported and collected through the same questionnaire with cross-sectional research design. It is a major cause of systematic measurement error, which can either inflate or deflate observed relationships between constructs of interest (Podsakoff, MacKenzie, Lee & Podsakoff, 2003; Podsakoff & Organ, 1986). Therefore, Common Method variance is tested with Harman's one-factor test. All the seven second-order factors from the manufacturing sector and eight from services sector were subjected separately to exploratory factor analysis (EFA) using (1) un-rotated principal components factor analysis, (2) principal component analysis with varimax rotation, and (3) principal axis analysis with varimax rotation. EFA is mainly to decide the number of factors that are necessary to account for the variance in the variables. If either (a) a single factor emerges from the factor analysis, or (b) one general factor accounts for the majority of the covariance among the variables (Podsakoff et al., 2003; Podsakoff & Organ, 1986), it can be concluded that there is a substantial presence of common method variance.

Table 3.17: Harman's One-Factor Test (Manufacturing Sector)

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	2.255	32.215	32.215	1.833	26.192	26.192
2	1.496	21.370	53.585	1.121	16.014	42.206
3	1.034	14.770	68.355	.525	7.500	49.706
4	.766	10.944	79.299			
5	.692	9.888	89.187			
6	.490	6.996	96.182			
7	.267	3.818	100.000			

Table 3.18: Harman's One-Factor Test (Services Sector)

Factor	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	1.618	20.221	20.221	1.242	15.525	15.525
2	1.419	17.736	37.957	.818	10.222	25.747
3	1.206	15.080	53.037	.324	4.055	29.802
4	1.000	12.495	65.532			
5	.900	11.245	76.778			
6	.877	10.964	87.742			
7	.596	7.445	95.187			
8	.385	4.813	100.000			

All the three (3) EFAs revealed the presence of three (3) distinct factors with Eigenvalue higher than one in the sectors. The result from Principal axis analysis with varimax rotation is presented in the tables 3.17 and 3.18. The three factors together accounted for a considerable percentage of the total variance, and the first factor (largest factor) did not account for a majority of the variance. Therefore, there is no apparent single factor emerged from the factor analysis and no general factor accounting for the majority of the covariance among the variables. Therefore, it can be concluded that there is no apparent common method variance in the data. The following topic summarises this chapter.

3.11. Summary

This chapter explains the researcher's philosophical stance. It also covers the research processes and research model used in the study. Due to the lack of empirical investigations and thus indicators of measurement for the dimensions of NIS, the suitability of the instrument (innovation survey) to measure the variables of the model is discussed, and hybrid factor analytic method is introduced to test the first hypothesis. Also, due to the complexity and explanatory nature of the research model with latent variables including formative constructs, partial least squares (PLS) path modelling is selected to test the research model and study hypotheses 2 and 3. Finally, the preliminary details of the sample are reported. The following chapters 4, 5 and 6 present the findings for the hypotheses 1, 2 and 3 respectively.

CHAPTER 4: MEASURING NATIONAL INNOVATION SYSTEM: A SCALE DEVELOPMENT STUDY USING INNOVATION SURVEY

4.1. Introduction

The literature indicated that there are large sets of inter-correlated variables that describe the internal conceptual structure of NIS from firms' perspective. It further comprehended that manufacturing and services sectors differ in the conceptual structure. Within the sectors, the conceptual structure further differs based on the location, size and type of ownership of the firm. This chapter presents the findings for the first research objective. The objective is to explore the measures of National Innovation System (NIS) regarding firm attributes and their contexts empirically, which can be comprehensively assessed for the innovation outcomes.

The hypothesis associated with this objective is:

H_1 : ***There exists an underlying hierarchical factor structure (latent constructs) of the firm and national context related dimensions in the observations of firms' innovation activities within NIS.***

As discussed in the literature, firms are heterogeneous, and they differ based on sectors. Therefore, hypothesis 1 was tested in sub-hypotheses as presented below:

$H_{1.1}$: *There exists an underlying two-level factor structure of the firm and national context related dimensions in the observations of firms' innovation activities in manufacturing sector within NIS.*

$H_{1.2}$ *There exists an underlying two-level factor structure of the firm and national context related dimensions in the observations of firms' innovation activities in services sector within NIS.*

$H_{1.3}$ *Firm and context related dimensions within NIS differ between manufacturing and services sectors.*

Uncovering the underlying measures or factor structure of NIS is highly exploratory. A factor analytic model using hybrid method is employed to explore the structure of NIS from the 88 items from manufacturing and 78 items from services sectors after treating for missing values and outliers as indicated in the methodology section. Analyses are performed using the version 21 of IBM-SPSS, and SmartPLS 3.0 software. This section presents the outcome of the hybrid method of factor analysis used in the study followed by the validation of the factors. The outline of this section includes internal consistency and sampling adequacy, first-order factor extraction, second-order factor extraction and validation of the factors.

4.2. Internal Consistency and Sample Adequacy

Before extracting the factors, data were analysed to determine the degree of internal consistency (reliability) and sampling adequacy. The results for the seven groups or sections considered are presented in table 4.1. Cronbach alpha statistic is used to measure the level of reliability. Based on Nunnally and Bernstein (1994), an alpha value of 0.7 or above is considered acceptable as a good indication of reliability. Based on the results, manufacturing sector shows alpha values for all the seven groups 0.8 or more and services sector with 0.7 or more, which is a good indication of reliability as suggested by Nunnally and Bernstein (1994). These results depict that the scales were internally reliable or consistent, which indicate that the measurement procedure was accurate and precise. Suhr

(1991) indicated that instruments with low reliability are a limitation in EFA. Therefore, the measurements considered are reliable to be used for EFA.

Inadequate sample size can severely influence the reliability of the factor analysis (Field, 2000; Habing, 2003). The sample was checked for sampling adequacy using several assessments including examination of the anti-image correlation matrix, Bartlett's (1954) test of sphericity, and a summary measure devised by Kaiser (1970) known as the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy (MSA). Based on Field (2000), all elements on the diagonal of anti-image correlation matrix should be higher than 0.5 if the sample is adequate. An examination of the anti-image correlation matrix of the seven groups of aggregated items showed values higher than 0.5 along the diagonal for all items. The other two (2) test results are presented in table 4.1. Based on Hair, Anderson, Tatham and Black (1995), Bartlett's test of sphericity is a statistical test that examines the presence of correlations among the variables. The current analysis of this test showed significant results for the seven groups, which indicates that the data is suitable for factor analysis. The KMO MSA indicates the proportion of common variance in the items that may be attributed to the latent variable (Kaiser, 1970). This analysis showed a KMO MSA value of 0.7 or more for all the groups of data in the manufacturing sector and 0.6 or more for services sector except for 'patent and other protection methods', which is 0.500. Kaiser (1970) suggested 0.5 as a cut-off value for KMO MSA and proceeding with factor analysis with the KMO score of 0.6. All the three assessments fulfilled the requirement for sampling adequacy except for one group, even that group reached the cut-off value suggested by Kaiser and produced significant results in Bartlett's Test of Sphericity. These results indicated a high amount of variance shared between the items and sufficient non-zero correlations in the matrix to justify further analysis.

Table 4.1: Reliability and Sampling Adequacy of the Groups of Data (M-Manufacturing, S-Services)

No	Title of the Group or Section from the Survey	Number of items (after treating missing values and outliers)		Reliability Statistics Cronbach's Alpha		Kaiser-Meyer-Olkin Measure of Sampling Adequacy		Bartlett's Test of Sphericity Approx. Chi-Square		df		Sig.	
		M	S	M	S	M	S	M	S	M	S	M	S
1	Innovation Activities and Expenditure	9	9	0.850	.891	0.848	.773	1436.090	4949.774	36	36	0.000	0.000
2	Government Support for Innovation	7	7	0.882	.700	0.816	.655	1809.081	2120.588	21	21	0.000	0.000
3	Funding	20	18	0.800	.778	0.718	.600	6942.243	9324.912	190	55	0.000	0.000
4	Innovation Cooperation	8	8	0.934	.938	0.892	.895	2991.721	7305.874	28	28	0.000	0.000
5	Sources of Information for Innovation	13	13	0.956	.937	0.920	.838	5799.990	11312.271	78	78	0.000	0.000
6	Patent & Other Protection Methods	8	8	0.965	.861	0.930	.500	4083.171	7305.874	28	28	0.000	0.000
7	Factors that hamper Innovation	23	15	0.950	.927	0.891	.759	8447.931	12908.847	253	105	0.000	0.000
	Total	88	78										

4.3. First-order Factor Structure

As discussed in the methodology section, extraction of first-order factors using multiple factor analysis (MFA) involves two steps. The first step of the MFA, which is a Principal Component Analysis (PCA), retained 81 out of 88 items from the manufacturing sector and 65 out of 78 items from services sector with a factor loading of at least 0.5. The number of items retained from each section and the first (and the largest) eigenvalue of the section are presented in table 4.2.

Table 4.2: Number of Items Retained and First Eigenvalues of Data Groups

No	Title of the Group of items	No of items		No of items with at least a factor loading of 0.5		First and the largest Eigenvalue	
		M	S	M	S	M	S
1	Innovation Activities and Expenditure	9	9	9	9	4.145	4.898
2	Government Support for Innovation	7	7	7	7	4.126	2.582
3	Funding	20	18	17	11	4.434	3.791
4	Innovation Cooperation	8	8	8	8	5.497	5.654
5	Sources of Information for Innovation	13	13	13	13	8.574	7.528
6	Patent & Other Protection Methods	8	8	8	2	6.413	4.078
7	Factors that hamper Innovation	23	15	19	15	11.116	7.732
	Total	88	78	81	65		

These 81 items from Manufacturing and 65 from Services are treated further. The treatment involves normalising the data by dividing all items of each section by the square root of the first eigenvalue of that particular section obtained from its PCA in step 1. Now the normalised datasets are suitable to be merged with any section for further manipulation.

The second step of MFA involves merging the data and performing a global analysis to extract factors using PCA. The variables are combined into three groups based on activities in which firms have direct control, the environment in which firms operate and misalignments or barriers. This grouping is done to extract conceptually and practically sound factors. The first group includes the items from 'Innovation Activities and Expenditure' and 'Innovation Co-operation'. The second group consists of items from 'Government Support for Innovation', 'Funding', 'Sources of Information for Innovation' and 'Patents and Other Protection Methods'. The third group consists of items from the section on 'Factors Hampering Innovation Activities'. A summary of the factors extracted is presented in table 4.3.

Table 4.3: Number of First-order Factors Extracted (M- Manufacturing, S- Services)

No	Group of items	No of items		No of first-order factors		No of items	
		M	S	M	S	M	S
1	Firms' activities in which they have control over (activities & expenditure, cooperation)	17	17	3	4	17	14
2	The environment in which Firms operate (Government Support, Funding, sources of information & Intellectual Property Protection Methods)	45	33	8	9	44	33
3	Mismatch (Factors hampering innovation activities)	19	15	5	4	19	15
	Total	81	65	16	17	80	62

Out of the 81 items, 80 items returned from the manufacturing sector in step 2 PCA of MFA with the factor loading of 0.5 or more and segregated into 16 factors altogether at the level of first-order. Only 62 items out of 65 from Services sector returned with the factor loading of 0.5 or more. These items are grouped into 17 first-order factors. The indicators representing the first-order factors (with number of indicators, reliability, first Eigenvalue, % variance explained and cumulative % variance explained) from stage 2 MFA for both manufacturing and services sectors are attached as Appendix C-1 with sections ‘a’ and ‘b’. The tables in Appendix C-1 also provide the minimum and maximum factor loadings and communalities.

4.3.1. Labelling of First-order Factors

The label of a factor is developed based on its appropriateness for representing the underlying dimensions of that particular factor (Hair et al., 2012). The first-order factors are assigned names based on their conceptual relevance and practical meaning. These factors are then matched against the concepts regarding elements of NIS discussed in the literature. The labelling details of the first-order factors of both manufacturing and services sectors are presented in table 4.4.

Table 4.4: Labelling of First-order Factors

No	Manufacturing Sector			Services Sector		
	Items from Manufacturing Sector	**Conceptual relevance**	**Factor Name**	**Items from Services Sector**	**Conceptual relevance**	**Factor Name**
1	IC2 - Innovation co-operation with suppliers of equipment, materials, components, services or software IC3 – Innovation co-operation with clients or customers IC1 – Innovation co-operation with other companies within your company group IC5 – Innovation co-operation with consultants IC8 – Innovation co-operation with Government or public research institutes IC4 – Innovation co-operation with competitors or other companies in your industry IC6 – Innovation co-operation with commercial laboratories and private R&D institutes IC7 – Innovation co-operation with universities or other higher education institutes	These items reflect firms' co-operation with different stakeholders. Concept: Co-operation or Networking	Co-operation (Coop)	IA 5 – Internal or external training for the firms' personnel IA 3 – Acquisition of machinery, equipment and software IA 6 – Market Introduction of Innovations IA 1 – In-house R&D (intramural R&D) IA 7 – All forms of Design	These items reflect on the firms' capability to develop and utilise internal resources. Concept: Firms' Capability	Internal Resource Capability (IRCap)
2	IA 1 – In-house R&D (intramural R&D) IA 3 – Acquisition of machinery, equipment and software IA 5 – Internal or external training for the firms' personnel IA 6 – Market Introduction of Innovations IA 7 – All forms of Design IA 9 – Preparation for organisational innovation	These items reflect on the firms' capability to develop and utilise internal resources Concept: Firms' Capability	Internal Resource Capability (IRCap)	IC1 – Innovation co-operation with other companies within your company group IC5 – Innovation co-operation with consultants IC4 – Innovation co-operation with competitors or other companies in your industry	These items reflect the co-operation with industry related stakeholders. Concept: Co-operation or Networking	Inter-firm Cooperation (InFmCoop)
3	IA 4 – Acquisition of external knowledge IA 2 – Acquisition of R&D (extramural R&D) IA 8 – Preparing for marketing innovation	These items reflect on the firms' capability to utilise external resources. Concept: Firms' Capability	Externally Acquired Capability (EACap)	IC7 – Innovation co-operation with universities or other higher education institutes IC8 – Innovation co-operation with Government or public research institutes IC6 – Innovation co-operation with commercial laboratories and private R&D institutes	These items reflect the co-operation with institutions that produce scientific knowledge. Concept: Co-operation or Networking	Scientific Knowledge Cooperation (SKCoop)

No	Manufacturing Sector			Services Sector		
	Items from Manufacturing Sector	**Conceptual relevance**	**Factor Name**	**Items from Services Sector**	**Conceptual relevance**	**Factor Name**
	‘Table 4.4, continued’.					
4	SI 4 - Information source from Clients or customers SI 1 – Information source from within the company SI 5 – Information source from competitors and other companies from the same industry SI 3 – Information source from suppliers of equipment, materials, services or software SI 10 – information source from conferences, trade fairs, exhibitions SI 11 – information source from scientific journals and trade and technical publications SI 6 – information source from consultants SI 12 –Information source from Professional and industry associations SI 13 – information source from technical, industry and service standards SI 2 – information source from other companies within the company group SI 7 – information source from commercial laboratories and private R&D labs SI 9 – information source from Government and public research institutes SI 8 – information source from universities or other higher education institutes	These items reflect on the sources of information available for firms to make use of for innovation activities. Concept: Knowledge Infrastructure	Knowledge Infrastructure for Information (KInfInf)	IA 9 – Preparation for organisational innovation IA 2 – Acquisition of R&D (extramural R&D) IA 8 – Preparing for marketing innovation	These items reflect on the firms’ capability to utilise external resources. Concept: Firms’ Capability	Externally Acquired Capability (EACap)
5	PM 8 – Lead-time advantage on competitors PM 5 – Confidentiality agreements PM 4 – Copyrights PM 1 – Registration of Design PM 6 – Secrecy PM 2 – Trademarks PM 7 – Complexity of Design PM 3 - Patents	These items reflect on the intellectual property protections available for firms to protect their innovation. Concept: Institution	Intellectual Property Protection (IPP)	SI 12 –Information source from Professional and industry associations SI 2 – information source from other companies within the company group SI 6 – information source from consultants SI 10 – information source from conferences, trade fairs, exhibitions SI 13 – information source from technical, industry and service standards	These items reflect on the sources of industry / professional information available for firms to make use of for innovation activities. Concept: Knowledge Infrastructure	Industry Knowledge Infrastructure (IKInf)

No	Manufacturing Sector			Services Sector		
	Items from Manufacturing Sector	**Conceptual relevance**	**Factor Name**	**Items from Services Sector**	**Conceptual relevance**	**Factor Name**
	'Table 4.4, continued'.					
6	F_PrS4 – Private source of funding for marketing innovations F_PrS3 – Private source of funding for organisational innovations F_PrS5 – Private source of funding for R&D F_PrS2 – Private source of funding for process innovations F_PrS1 – Private source of funding for product innovations	These items reflect on the private funding available for firms to carry out their innovation activities. Concept: Funding Infrastructure	Private Funding Infrastructure (PrFInf)	SI 3 – Information source from suppliers of equipment, materials, services or software SI 7 – information source from commercial laboratories and private R&D labs SI 1 – Information source from within the company SI 5 – Information source from competitors and other companies from the same industry SI 4 - Information source from Clients or customers	These items reflect on the sources of business information available for firms to make use of for innovation activities. Concept: Knowledge Infrastructure	Business Knowledge Infrastructure (BKInf)
7	GS 6 – Government support in terms of R&D grant GS 4 – Government support in terms of commercialisation of R&D fund GS 7 – Government support in terms of innovation grant	These items reflect on all the support rendered by the Government regarding grants, tax incentives etc. for innovation.	Public Institution (PuIns)	F_OwS 1 - Own source of funding for product innovations F_OwS 3 – Own source of funding for organisational innovations F_OwS 5 – Own source of funding for R&D	These items reflect on the firms' ability to make use of their funding for innovation. Concept: Firms Capability	Financial Capability (FCap)
	'Table 4.4, continued'.					
	GS 5 – Government support in terms of tax incentive GS 3 – Government support in terms of duty-free importation of machinery or equipment F_PuS5 – Public source of funding for R&D	Concept: Institution		F_OwS 2 – Own source of funding for process innovations F_OwS 4 – Own source of funding for marketing innovations		
8	F_OwS 3 – Own source of funding for organisational innovations F_OwS 5 – Own source of funding for R&D F_OwS 4 – Own source of funding for marketing innovations F_OwS 2 – Own source of funding for process innovations F_OwS 1 - Own source of funding for product innovations	These items reflect on the firms' ability to make use of their funding for innovation. Concept: Firms Capability	Financial Capability (FCap)	F_PrS2 – Private source of funding for process innovations F_PrS1 – Private source of funding for product innovations F_PrS5 –Private source of funding for R&D	These items reflect on the private funding available for firms to carry out their innovation activities. Concept: Funding Infrastructure	Private Funding Infrastructure (PrFInf)

'Table 4.4, continued'.

No	Manufacturing Sector			Services Sector		
	Items from Manufacturing Sector	**Conceptual relevance**	**Factor Name**	**Items from Services Sector**	**Conceptual relevance**	**Factor Name**
9	F_PuS3 – Public source of funding for organisational innovations F_PuS2 – Public source of funding for process innovations F_PuS1 – Public source of funding for product innovations F_PuS4 - Public source of funding for marketing innovations	These items reflect on the public funding available for firms to carry out their innovation activities. Concept: Funding Infrastructure	Public Funding Infrastructure (PuFInf)	GS 4 – Government support in terms of commercialisation of R&D fund GS 5 – Government support in terms of tax incentive GS 3 – Government support in terms of duty-free importation of machinery or equipment	These items reflect on all the support rendered by the Government regarding grants, tax incentives etc. for innovation. Concept: Institution	Public Institution (PuIns)
10	F_OtS5 - Other source of funding for R&D F_OtS2 - Other source of funding for Process Innovations	These items reflect on the other funding available for firms to carry out their innovation activities. Concept: Funding Infrastructure	Other Funding Infrastructure (OtFInf)	SI 11 – information source from scientific journals and trade and technical publications SI 8 – information source from universities or other higher education institutes SI 9 – information source from Government and public research institutes	These items reflect on the sources of scientific information available for firms to make use of for innovation activities. Concept: Knowledge Infrastructure	Scientific Knowledge Infrastructure (SKInf)
11	GS 2 – Government support in terms of technical support services GS 1 – Government support in terms of technical consultancy services	These items reflect on the Governments support services regarding technical support and consultancy. Concept: Knowledge Infrastructure	Knowledge Infrastructure for Technical Support (KInfTS)	GS 6 – Government support in terms of R&D grant GS 1 – Government support in terms of technical consultancy services GS 7 – Government support in terms of innovation grant GS 2 – Government support in terms of technical support services	These items reflect on the Governments support services regarding technical support and consultancy. Concept: Knowledge Infrastructure	Knowledge Infrastructure for Technical Support (KInfTS)
12	FH 14 – Organizational rigidities within the enterprise in terms of attitude of managers towards change FH 15 – Organizational rigidities within the enterprise in terms of managerial structure of enterprise FH 13 – Organizational rigidities within the enterprise in terms of attitude of personnel towards change FH 16 – Inability to devote staffs to innovation activities due to production requirement FJ 11 – Uncertain demand for innovative goods and services	These items reflect on the misalignment between organisational setup and the intended innovation outcomes as national agenda. Concept: Transformational Factors	Org Directionality (OrgDir)	F_PuS4 - Public source of funding for marketing innovations F_PuS5 – Public source of funding for R&D F_OtS2 - Other source of funding for Process Innovations	These items reflect on the public and other funding available for firms to carry out their innovation activities. Concept: Funding Infrastructure	Public and Other Funding Infrastructure (FInf)

No	Manufacturing Sector			Services Sector		
	Items from Manufacturing Sector	**Conceptual relevance**	**Factor Name**	**Items from Services Sector**	**Conceptual relevance**	**Factor Name**
	'Table 4.4, continued'.					
13	FH 19 – Lack of networking with research institutes (e.g. Universities, SIRIM, FRIM etc.) FH 18 – Lack of facilities (e.g. Machine, equipment) FH 17 – Lack of infrastructure (e.g. Building) FH 8 – Difficulties in finding cooperation partners for innovation FH 20 – Insufficient flexibilities of regulation and standards	These items measure the lack of coordination regarding networking, infrastructure and regulations and standards. Concept: Transformational Factors	Notion of Coordination (NCo)	PM 8 – Lead-time advantage on competitors PM 7 – Complexity of Design	These items reflect on the intellectual property protections available firms to protect their innovation. Concept: Institution	Intellectual Property Protection (IPP)
14	FH 2 – Lack of funds within the organisation FH 3 – Lack of finance from sources outside the organisation FH 4 – Excessive perceived risk FH 1 – Cost too high	These items reflect on the misalignment between resource allocation within firms and the intended innovation outcomes as national agenda. Concept: Transformational Factors	Resource Directionality (FDir)	FH 3 – Lack of finance from sources outside the organisation FH 8 – Difficulties in finding cooperation partners for innovation FH 9 – Weakness of intellectual property knowledge and rights FH 7 – Lack of information on markets FH 4 – Excessive perceived risk FH 6 – Lack of information on technology	These factors reflect on the unavailability of the information needed at the right time for innovation. Concept: Market factors	Information Asymmetries (InfAsy)
15	FH 6 – Lack of information on technology FH 7 – Lack of information on markets FH 5 – Lack of qualified personnel	These factors reflect on the unavailability of the information needed at the right time for innovation. Concept: Market factors	Information Asymmetries (InfAsy)	FH 11 – Uncertain demand for innovative goods and services FH 10 – Market dominated by established enterprise FH 12 – Innovation is easy to imitate	These factors reflect misalignment in articulating demand. Concept: Transformational Factors	Demand Articulation (DeArt)
16	FH 23 – No need because lack of demand for innovation FH 22 – No need to innovate due to earlier innovations	These factors reflect misalignment in articulating demand. Concept: Transformational Factors	Demand Articulation (DeArt)	FH 14 – Organizational rigidities within the enterprise in terms of attitude of managers towards change FH 13 – Organizational rigidities within the enterprise in terms of attitude of personnel towards change FH 15 – Organizational rigidities within the enterprise in terms of managerial structure of enterprise	These items reflect on the misalignment between organisational setup and the intended innovation outcomes as national agenda. Concept: Transformational Factors	Org Directionality (OrgDir)

No	Manufacturing Sector			Services Sector		
	Items from Manufacturing Sector	Conceptual relevance	Factor Name	Items from Services Sector	Conceptual relevance	Factor Name
	'Table 4.4, continued'.					
17				FH 2 – Lack of funds within the organisation FH 1 – Cost too high FH 5 – Lack of qualified personnel	These items reflect on the misalignment between resource allocation within firms and the intended innovation outcomes as national agenda Concept: Transformational Factors	Resource Directionality (FDir)

4.3.2. Interpretation of First-order Factors

The eigenvalue >1 criterion resulted in 16 first-order factors (3 factors for firms' activities explaining 64% of the variance, eight factors for firms' environment explaining 76% of the variance and five factors for misalignments explaining 76% of variance) in the manufacturing sector. However, 17 factors were extracted (4 factors for firms' activities explaining 79% of the variance, nine factors for firms' environment explaining 79% of the variance and four factors for misalignments explaining 83% of variance) from the services sector. All items were accounted for the factors with an estimated factor loading of more than 0.5 and communalities of more than 0.3 and thus with substantial interpretability. The factor structure was relatively clean with no overlap in factor loading. The internal consistencies of the items measuring the first-order factors were checked, and the reliability alpha score is above 0.8 except for a few with a score of 0.6 (one factor from services with the score of and 0.621) and 0.7 (one from the manufacturing sector and two from services sector). Based on the rules of thumb of George and Mallery (2003), only the reliability scores equivalent to or below 0.5 are inadequate and unacceptable. While the score in the range of 0.7 and above is acceptable, the ones in the range of 0.6 and above are challengeable yet acceptable. Since there is only one item in the range of 0.6, it is acceptable considering its theoretical relevance. The first-order factors extracted for both manufacturing and services sectors are presented in table 4.5 based on the labelling done in table 4.4.

Table 4.5: Firm-related and Contextual First-order Factors

No	Firm-related		Contextual	
	Manufacturing	**Services**	**Manufacturing**	**Services**
1	Cooperation	Internal Resources Capability	Knowledge Infrastructure for Information	Industry / Professional Knowledge Infrastructure
2	Internal Resources Capability	Inter-firm Cooperation	Intellectual Property Protection	Business Knowledge Infrastructure
3	Externally Acquired Capability	Scientific Knowledge Cooperation	Private Funding Infrastructure	Private Funding Infrastructure
4	Financial Capability	Externally Acquired Capability	Public Institution	Public Institution
5	Organisational Directionality	Financial Capability	Public Funding Infrastructure	Scientific Knowledge Infrastructure
6	Notion of Coordination	Demand Articulation	Other Funding Infrastructure	Technical Support Infrastructure
7	Financial Directionality	Financial Directionality	Technical Support Infrastructure	Public and Other Funding Infrastructure
8	Demand Articulation	Resources Directionality	Information Asymmetries	Intellectual Property Rights
				Information Asymmetries

Examination of the factor inter-correlation matrix revealed that most factors had substantial correlations with at least one other factor. Thus, a second-order factor analysis was in order. The second-order factor structure extracted is discussed in the next section.

4.4. Second-order Factor Structure

The process used to extract the first-order factor is continued once again with the first-order factors as the indicators to extract the second-order factors as stipulated by Gorsuch (1983). The author also added that constructing an inter-factor matrix of associations (R, factors by factors) includes extracting factors from it using PCA or another suitable method. The resultant higher-order factor matrix (H, factors by higher-order factors) can then be rotated. As indicated earlier, different extraction techniques and rotation methods, are tried to choose the outcomes with conceptual as well as practical relevance. PCA is employed here as it extracted conceptually and practically relevant factors. 16 first-order factors from the manufacturing sector and 17 from services sector are employed for the analysis. They are split into firm related factors and contextual factors as shown in table 4.6 and 4.7 for the PCA.

EFA employed on the first-order factors from manufacturing and services sectors individually with PCA and varimax rotation extracted second-order factors. The extracted factors, their Eigenvalues and percentage variance explained are presented in tables 4.6 and 4.7.

Table 4.6: Second-order Factors for Manufacturing Sector

No	Factors	Indicators	No. of indicators	Initial Eigenvalue	% Variance Explained	Cumulative % Variance Explained
	Firms' Attributes	**Factor loading: Min. -0.** 552; **Max-0.** .877 **Communalities: Min. –0.** .310; **Max. – 0**.786				
1	Transformative Actions	Demand Articulation First-order Notion of Coordination First-order Financial Directionality First-order Organisational Directionality First-order	4	2.848	35.599	35.599
2	Firms' Capability and Collaboration	Financial Capability First-order Internally Embodied Capability First-order Cooperation First-order Externally Acquired Capability First-order	4	1.725	21.560	57.159
			8			
	Contextual Attributes	**Factor loading: Min. -0.638 ; Max-0.915 Communalities: Min. – 0.** 580; **Max. – 0.845**				
3	Knowledge & Funding Infrastructure and Institution for Private Sources	Intellectual Property Protection First-order Private Funding Infrastructure First-order Knowledge Infrastructure for Information First-order	3	2.269	28.367	28.367
4	Knowledge Infrastructure and Institution for Public Sources	Public Institution First-order Knowledge Infrastructure for Technical Support from the Government First-order	2	1.372	17.151	45.517
5	Funding Infrastructure	Public Funding Infrastructure First-order Other Funding Infrastructure First-order	2	1.079	13.484	59.001
6	Market Knowledge Factor	Information Asymmetries First-order	1	1.018	12.728	71.729

Table 4.7: Second-order Factors for Services Sector

No	Factors	Indicators	No. of indicators	Initial Eigenvalue	% Variance Explained	Cumulative % Variance Explained
	Firms' Attributes	**Factor loading: Min. -0.643; Max-0.**984 **Communalities: Min. –0.426; Max. – 0**.971				
1	Transformative Actions	Organisational Directionality First-order Resource Directionality First-order Demand Articulation First-order	3	1.793	22.418	22.418
2	Cooperation	Scientific Knowledge Cooperation First-order Inter-firm Cooperation First-order	2	1.588	19.856	42.274
3	Resource Capability	Externally Acquired Capability First-order Internally Embodied Capability First-order Cooperation First-order	2	1.433	17.914	60.188
4	Financial Capability	Financial Capability First-order	1	1.002	12.522	72.710
			8			
	Contextual Attributes	**Factor loading: Min. -0.626 ; Max-0.907 Communalities: Min. – 0.400; Max. – 0.827**				
5	Knowledge Infrastructure	Scientific Knowledge Infrastructure First-order Industry Knowledge Infrastructure First-order Business Knowledge Infrastructure First-order	3	2.149	23.876	23.876
6	Knowledge Market Factors	Information Asymmetries First-order Intellectual Property Protection First-order	2	1.628	18.088	41.965
7	Public Infrastructure and Institution	Technological Support Infrastructure First-order Financial Institution First-order	2	1.131	12.563	54.527
8	Funding Infrastructure	Private Funding Infrastructure First-order Public and Other Funding Infrastructure First-order	2	1.113	12.363	66.891

EFA employed on the first-order factors extracted six second-order factors (two factors explaining 57% variance of the first-order firm related factors and four factors explaining 72% variance of the first-order contextual factors) from the manufacturing sector. A similar analysis with the data from services sector extracted eight second-order factors (four factors explaining 72% variance of the first-order firm related factors and another four factors explaining 67% variance of the first-order contextual factors). All items were accounted for the factors with an estimated factor loading of more than 0.5 and communalities of more than 0.4 and thus with substantial interpretability. The factor structure was relatively clean with no overlap in factor loading. An inspection of the second-order factor correlation matrix no longer showed substantial correlations among second-order factors. Thus a third-order factor analysis was not appropriate. Third-order factor analysis also takes the examination of NIS from farther than the national context, and it may not be useful regarding policy devising.

4.4.1. Labelling of Second-Order Factors

This step checks and identifies the name or theme of the second-order factors with the theoretical and conceptual intent and matches against the elements discussed in the literature. The interpretation of second-order factors is presented in table 4.8.

Table 4.8: Interpretation of Second-order Factors

No	Indicators (First-order Factors)	Manufacturing Sector: Conceptual Relevance	Manufacturing Sector: Second-order Factor Name	Indicators (First-order Factors)	Services Sector: Conceptual Relevance	Services Sector: Second-order Factor Name
	Firms' Attributes **Factor loading: Min. -0.** 552; **Max-0.** .877 **Communalities: Min. –0.** .310; **Max. – 0**.786			**Firms' Attributes Factor loading: Min. -0.643; Max-0.**984 **Communalities: Min. –0.426; Max. – 0**.971		
1	Demand Articulation Notion of Coordination Resources Directionality Organisational Directionality	These first-order factors together form the concept of misalignment in articulating demand, coordination, organisational set-up and resources allocation. Concept: Transformative Actions	Transformative Actions	Organisational Directionality Resources Directionality Demand Articulation	These first-order factors together form the concept of misalignment in articulating demand, organisational set-up and resources allocation.	Transformative Actions
2	Financial Capability Internal Resources Capability Cooperation Externally Acquired Capability	These first-order factors together form the concept of firms' capability covering resources, financial and cooperation, which is a structural element of firms. Here cooperation, which is an element by itself, is also a part of this factor. Concepts covered: Firms' Capability and collaboration	Firms' Capability and Collaboration	Scientific Knowledge Cooperation Inter-firm Cooperation	These first-order factors together form the concept of collaboration or networking, which is one of the key structural aspects of firms. Concept: Cooperation or Network	Cooperation
3				Externally Acquired Capability Internal Resources Capability	These first-order factors together form the concept of firms' capability covering firms' ability to use internal and external resources Concept: Firms' Capability	Resource Capability

'Table 4.8, continued'.

No	Indicators (First-order Factors)	Manufacturing Sector: Conceptual Relevance	Manufacturing Sector: Second-order Factor Name	Indicators (First-order Factors)	Services Sector: Conceptual Relevance	Services Sector: Second-order Factor Name
4				Financial Capability	This first-order factor on financial capability stands alone at the second-order indicating its strong pattern on its own. Concept: Firms' Capability	Financial Capability
	Contextual Attributes **Factor loading: Min. -0.638; Max-0.915** **Communalities: Min. – 0.** 580**; Max. – 0.845**			**Contextual Attributes** **Factor loading: Min. -0.626; Max-0.907** **Communalities: Min. – 0.400; Max. – 0.827**		
1	Intellectual Property Protection Private Funding Infrastructure Knowledge Infrastructure for Information	These first-order factors together form a structure for institution and infrastructure for private sources. Concepts: Infrastructure and Institutions	Knowledge & Funding Infrastructure and Institution for Private Sources	Scientific Knowledge Infrastructure Industry or Professional Knowledge infrastructure Business Knowledge Infrastructure	These first-order factors together form a structure for knowledge infrastructure Concept: Infrastructure	Knowledge Infrastructure
2	Public Institution Knowledge Infrastructure for Technical Support from the Government	These first-order factors together form a structure for government support regarding institutions and Technical Support. Concept: Infrastructure and Institution	Government Support	Information Asymmetries Intellectual Property Protection	These first-order factors together form a structure for indicating lack of information in the market and the IPP. When there is stringent IPP, the information or knowledge required is not readily available. Concept: Knowledge Market	Market Knowledge Factors
3	Public Funding Infrastructure Other Funding Infrastructure	These first-order factors together form a structure for funding infrastructure apart from private funding. Concept: Infrastructure	Public and Other Funding Infrastructure	Public Institution Knowledge Infrastructure for Technical Support from the Government	These first-order factors together form a structure for government support regarding institutions and Technical Support. Concept: Infrastructure and Institution	Government Support

No	Indicators (First-order Factors)	Manufacturing Sector		Indicators (First-order Factors)	Services Sector	
		Conceptual Relevance	Second-order Factor Name		Conceptual Relevance	Second-order Factor Name
	'Table 4.8, continued'.					
6	Information Asymmetries	This first-order factor stands alone at the second-order indicating its strong pattern on its own. Concept: Market Factor	Market Knowledge Factor	Private Funding Infrastructure First-order Public and Other Funding Infrastructure First-order	These first-order factors together form a structure for funding infrastructure. Concept: Infrastructure	Funding Infrastructure

4.4.2. Interpretation of Second-Order Factors

The analysis extracted 6 second-order factors for the manufacturing sector and 8 for the services sector. The second-order factors extracted for both manufacturing and services sectors are presented in table 4.9 based on the labelling done in table 4.8.

Table 4.9: Firm-related and Contextual Second-order Factors

No	Firm-related		Contextual	
	Manufacturing	**Services**	**Manufacturing**	**Services**
1	Transformative Actions	Transformative Actions	Knowledge & Funding Infrastructure and Institution for Private Sources	Knowledge Infrastructure
2	Capability (includes cooperation)	Cooperation	Government Support	Market Knowledge Factors
3		Resource Capability	Public and Other Funding Infrastructure	Government Support
4		Financial Capability	Market Knowledge Factor	Funding Infrastructure

This study has uncovered 16 first-order and 6 second-order factors or constructs for the manufacturing sector and 17 first-order and 8 second-order constructs for services sectors. These constructs require validation.

4.5. Construct Validity of First and Second-Order Factors

The factors extracted are checked for construct validity in the SmartPLS software. Construct validity is meant to check whether the measures projected the construct or not (measurement model evaluation). This study employed 'repeated indicator approach' to avoid interpretational confounding as discussed in the methodology chapter. In the repeated indicator approach, a higher-order latent variable is constructed by specifying a latent variable that represents all the manifest variables of the underlying lower-order latent variables (Lohmoller, 1989; Noonan and Wold, 1983; Wold, 1982). All the constructs (both first-order and second-order) established were checked for validity by establishing a model for each connecting them to innovation outcomes as suggested by Wong (2013). The models of constructs were built correctly in the SmartPLS software, and essential statistics were estimated by running a PLS algorithm (2000 maximum iteration).

The appropriateness of the first-order reflective constructs is checked first. Based on Becker et al. (2012) and Wong (2013), conceptual properties of the lower-order constructs (reflective constructs) were reported with indicator loadings and their significance, Average Variance Extracted (AVE), composite reliability and discriminant validity. These details are reported in table 4.10 and 4.11. A detailed table with indicators of the factors, their factor loading, t-statistics and indicator reliability (i.e. loadings^2) is provided in Appendix C-2.

4.5.1. Construct Validity of First-order Factors

Table 4.10: Construct Validity of First-order Factors – Manufacturing Sector

No	Latent Variable	Composite Reliability	AVE
	Firms' Attributes		
1	Own Source of Fund	0.925	0.713
2	External Resources Capability	0.804	0.579
3	Internal Resource Capability	0.881	0.553
4	Cooperation	0.946	0.687
5	Organisational Directionality	0.939	0.755
6	Notion of Coordination	0.896	0.634
7	Resource Directionality	0.91	0.717

'Table 4.8, continued'.

8	Demand Articulation	0.958	0.92
	Contextual Attributes		
9	Private Funding Infrastructure	0.962	0.834
10	Knowledge Infrastructure for Information	0.962	0.659
11	Intellectual Property Protection	0.970	0.802
12	Public Institution	0.907	0.623
13	Government Technical Support Infrastructure	0.911	0.836
14	Public Funding Infrastructure	0.834	0.558
15	Other Funding Infrastructure	Single item construct	
16	Information Asymmetries	0.916	0.784

Table 4.11: Construct Validity of First-order Factors – Services Sector

No	Latent Variable	Composite Reliability	AVE
	Firms' Attributes		
1	Inter-firm Cooperation	0.972	0.919
2	Scientific Knowledge Cooperation	0.908	0.766
3	Own Source of Funding	0.919	0.695
4	External Resource Capability	0.928	0.812
5	Internal Resource Capability	0.938	0.753
6	Demand Articulation	0.931	0.819
7	Organisational Directionality	0.873	0.696
8	Resource Directionality	0.902	0.757
	Contextual Attributes		
9	Business Knowledge Infrastructure	0.958	0.820
10	Industry Knowledge Infrastructure	0.934	0.741
11	Scientific Knowledge Infrastructure	0.924	0.803
12	Financial Institution	0.903	0.756
13	Technical Support Infrastructure	0.829	0.550
14	Public and Other Funding Infrastructure	0.800	0.570
15	Private Funding Infrastructure	1.000	1.000
16	Information Asymmetries	0.967	0.829
17	Intellectual Property Protection	0.976	0.954

A summary of the assessment of the first-order reflective constructs of both manufacturing and services sectors is presented in table 4.12.

Table 4.12: Summary of the Evaluation of First-order Reflective Measures

No	Evaluation	Criterion	Result		Comment
			Manufacturing Sector	**Services Sector**	
1	Indicator reliability	Indicator loadings	All items loading exceed 0.4, ranging from 0.411 to 0.922. Further, all items are significant with the t-value ranging from 11.609 to 131.073 (>1.96)	Item loadings range from 0.604 to 0.977. Further, all items are significant with the t-value ranging from 14.64 to 310.244 (>1.96)	All items loaded more than 0.4 and significant, hence, demonstrating indicator reliability suitable for exploratory study. .
2	Internal consistency	Composite Reliability (CR)	CR values of constructs range from 0.804 to 0.97	CR values of constructs range from 0.800 to 0.976	Equal to or exceeded 0.8, thus demonstrating internal consistency except for one of the constructs in the manufacturing sector
3	Convergent validity	Average Variance Explained (AVE)	AVE values of constructs range from 0.553 to 0.92	AVE values of constructs range from 0.55 to 0.954	Each construct has an AVE value more than 0.5, thus demonstrating convergent validity except for one of the constructs in the manufacturing sector
4	Discriminant validity	Cross loading	All items load with a high loading for its respective constructs		There is no cross loading.
		Fornell and Larcker criterion	The square root of AVE > the correlations between the construct and other constructs		The square root AVE is greater than the inter-correlations; Thus, demonstrating the discriminant validity

All these reflectively measured first-order factors (except for one single item construct from manufacturing sector) for both the sectors show satisfactory values for convergent validity and reliability (i.e., AVE above .50 and composite reliability above .70). Also fulfils the discriminant validity following the Fornell-Larcker criterion (Fornell and

Larcker, 1981; Henseler et al., 2009). Fornell and Larcker (1981) suggest that the square root of AVE in each latent variable can be used to establish discriminant validity if this value is larger than other correlation values among the latent variables. Therefore, it can be concluded that both manufacturing and services sectors have 15 and 17 valid and sound first-order factors respectively. The following section discusses the validity of second-order factors.

4.5.2. Construct Validity of Second-order Factors

The appropriateness of the second-order formative constructs is checked. As indicated and justified in the methodology section, this study followed reflective-formative indicator approach. Based on Becker et al. (2012) and Wong (2013), conceptual properties of the second-order constructs (formative constructs) or measurement model were reported with indicator weights, significance of weights, and multicollinearity of indicators as suggested by Cenfetelli and Bassellier (2009), Chin (1998), Fornell and Larcker (1981) and Hair et al. (2012).

Table 4.13: Construct Validity of Second-order Factors – Manufacturing Sector

No	Latent Variable	Indicators	Collinearity Statistics	
			VIF	Tolerance
	Firms' Attributes			
1	Firms' Capability	Cooperation	1.560	0.641
		External Resources Capability		
		Financial Capability (Own Source of Fund)		
		Internal Resources Capability		
2	Firms' Transformational Actions	Demand Articulation	1.599	0.625
		Notion of Coordination		
		Organizational Directionality		
		Resource Directionality		
	Contextual Attributes			
3	Knowledge & Funding Infrastructure and Institution for Private Sources			
		Intellectual Property Protection	1.412	0.708
		Knowledge Infrastructure for Information		
		Private Funding Infrastructure		
4	Government Support Infrastructure and Institution			
		Government Technical Support Infrastructure	1.387	0.721
		Public Institution		
5	Funding Infrastructure			
		Other Funding Infrastructure	1.156	0.865
		Public Funding Infrastructure		
6	Market Knowledge Factor			
		Information Asymmetries	1.412	0.708

Sixteen first-order and six second-order valid and sound factors are observed in firms' activities as dimensions of NIS to explain the national innovation outcomes from the manufacturing sector. The following is observed in the services sector.

Table 4.14: Construct Validity of Second-order Factors – Services Sector

No	Latent Variable	Indicators	Collinearity Statistics	
			VIF	Tolerance
	Firms' Attributes			
1	Firms' Cooperation	Inter-firm Cooperation	1.059	0.945
		Scientific Knowledge Cooperation		
2	Financial Capability	Own Source of Funding	1.015	0.985
3	Firms' Resource Capability	External Resource Capability	1.027	0.974
		Internal Resource Capability		
4	Firms' Transformational Actions	Demand Articulation	1.033	0.968
		Organisational Directionality		
		Resource Directionality		
	Contextual Attributes			
5	Knowledge Infrastructure	Business Knowledge Infrastructure	1.068	0.936
		Industry Knowledge Infrastructure		
		Scientific Knowledge Infrastructure		
6	Government Support Infrastructure and Institution	Financial Institution	1.015	0.985
		Technical Support Infrastructure		
7	Funding Infrastructure	Private Funding Infrastructure	1.012	0.988
		Public and Other Funding Infrastructure		
8	Knowledge Market Factor	Information Asymmetries	1.049	0.953
		Intellectual Property Protection		

Seventeen first-order and eight second-order valid and sound factors are observed in firms' activities as dimensions of NIS to explain the national innovation outcomes from the services sector. A summary of the assessment of the second-order formative constructs of both manufacturing and services sectors is presented in table 4.15.

Table 4.15: Summary of the Evaluation of Second-order Formative Measures

No	Criterion	Result		Comment
		Manufacturing Sector	**Services Sector**	
1	Outer model weight and significance	The weights of most of the indicators are significant (with t-value of <1.96). The insignificant ones had significant factor loadings.		All the indicators were retained as per Wong (2013) suggestions as these indicators are also conceptually relevant.
3	Collinearity of Indicators • Variance Inflation Factor (VIF) • Tolerance	The VIF values of the constructs range between 1.156 to 1.599.The tolerance values range from 0.625 to 0.865.	The VIF values of the constructs range between 1.012 to 1.068.The tolerance values range from 0.936 to 0.988.	All the constructs are within the rule of thumb, i.e., VIF of 5 or lower and Tolerance level of 0.2 or higher). Therefore there no evidence of collinearity issue.

All the formative second-order factors from both manufacturing and services sectors show satisfactory values for multicollinearity (i.e., tolerance above 0.5 and VIF less than 5.0). Therefore, the first-order and second-order factors extracted from both manufacturing and services sectors are valid and sound.

4.6. Comparison of Factor Structure of NIS between Manufacturing and Services Sectors

Manufacturing and services sectors are compared for their similarities and differences in their factor structure and presented in the topics below.

4.6.1. Comparison of First-order Measures of Manufacturing and Services Sectors

The first-order factors of manufacturing and services sector are compared for similarities and differences and presented in table 4.16.

Table 4.16: Comparison of First-Order Measures

No	Concepts	Manufacturing Sector	Services Sector	Comparison
	Context-Related	-		
1	Institutional Conditions (involve political, financial, labour and market institutions)	- Intellectual Property Protection - Government Support (Public Institution)	- Government Support (Public Institution) - Intellectual Property Protection -	No difference between the sectors. However, political and labour institutions are not covered in the survey.
2	Infrastructure (involve knowledge, physical, funding infrastructure)	- Knowledge Infrastructure for Information - Private Funding Infrastructure - Public Funding Infrastructure - Technical Support Infrastructure	- Industry knowledge Infrastructure - Business knowledge infrastructure - Scientific Knowledge Infrastructure - Private Funding Infrastructure - Public and Other Funding Infrastructure - Technical Support Infrastructure	Knowledge, funding and government technical support infrastructures are apparent. However, similar patterns exist only regarding Government technical support. Knowledge infrastructure emerged as a single factor in manufacturing but segregated into three different types namely industry knowledge, business knowledge and scientific knowledge in the services sector. Considering the funding infrastructure, it segregates into public and private funding infrastructure.
3	Market factor - Information asymmetries - Knowledge Spill-over - Externalisation of costs - Over-exploitation of commons	- Information asymmetries	- Information asymmetries	No difference. In both sectors, only the factor structure of 'information asymmetries' is apparent. It is also noted that the indicators for the other market elements such as 'knowledge spill-over', 'externalisation of cost' and 'over-exploitation of commons' are not apparent in the innovation survey.
	Firm-Related			
4	Capability (in producing, acquiring and using knowledge for innovation)	- Internal Resource capability - Externally Acquired Capability - Own Source of Funding (Financial Capability)	- Internal Resource capability - Externally Acquired Capability - Own Source of Funding (Financial Capability)	No difference between the sectors

No	Concepts	Manufacturing Sector	Services Sector	Comparison
	Table 4.16, continued'. -		-	
5	Interactions (knowledge flows) - (involving Involvement with Public Science systems and Authoritative Coordination)	- Cooperation	- Inter-firm cooperation - Scientific Knowledge Cooperation	It is noted here that co-operation emerged as a single factor in the manufacturing sector while it segregates into two factors 'inter-firm cooperation' and 'scientific-knowledge cooperation' in the services sector.
6	Transformational characteristics - Directionality - Demand articulation - Policy Coordination - Reflexivity	- Organisational Directionality - Notion of Coordination - Resource Directionality - Demand Articulation -	- Demand Articulation - Organisational Directionality - Resource Directionality	All are same for both sectors except 'notion of coordination', which was not extracted as a fundamental factor structure in the services sector.

Out of the 15 valid first-order factors from the manufacturing sector and 17 from the services sector, there are 11 similar factors and the rest are different, which accounts for around 35% difference (considering that there is a possibility to have a maximum of 17 first-order factors). Therefore, there is a difference between the manufacturing and services sectors in the first-order factor structure emerged from firms' activities within NIS.

4.6.2. Comparison of Second-order Measures of Manufacturing and Services Sectors

The second-order factors of manufacturing and services sector are compared for similarity and differences and presented in table 4.17.

Table 4.17: Comparison of Second-Order Measures

No	Concepts	Manufacturing Sector	Services Sector	Comparison
	Context-Related			
1	Institutional Conditions (involving political, financial, labour and market institutions)	- Infrastructure and Institution for Private Sources - Government Support Infrastructure and Institution	- Government Support Infrastructure and Institution	'Government support infrastructure and institution' emerged as one of the factors for both sectors. There is an additional factor 'infrastructure and institution for private sources' observed in the manufacturing sector. In both the sectors, the institutional dimension is not distinct; it is integrated with infrastructure.
2	Infrastructure (involving knowledge, physical, funding infrastructure)	- Public Funding Infrastructure	- Knowledge Infrastructure - Funding Infrastructure	Considering the dimension 'infrastructure', both the sectors distinctly differ. 'Public funding infrastructure' is obvious in the manufacturing sector. However, two factors 'knowledge infrastructure' and 'funding infrastructure' (without distinguishing the source of funding) are apparent.
3	Market factor - Information asymmetries - Knowledge Spill-over - Externalisation of costs - Over-exploitation of commons	- Market Knowledge Factor	- Market Knowledge Factor	'Market knowledge factor' emerges as a common factor for both the sectors.
	Firm-Related			
4	Capability (in producing, acquiring and using knowledge for innovation)	- Firms' Capability and Interactions	- Resource Capability - Financial Capability	The sectors differ distinctly here. Only one factor 'capability' (that includes all types of capabilities and interaction elements) emerges from the data for the manufacturing sector. However, two factors 'resource capability' and 'financial capability' emerge from the services sector.

No	Concepts Context-Related	Manufacturing Sector	Services Sector	Comparison
	Table 4.17, continued'. -		-	
5	Interactions (knowledge flows) - (involving Involvement with Public Science systems and Authoritative Coordination)		- Interactions	As explained above, the 'cooperation' element is integrated with 'capability' dimension for the manufacturing sector. However, for the services sector, it emerges as a separate dimension.
6	Transformational characteristics - Directionality - Demand articulation - Policy Coordination - Reflexivity	- Transformative Characteristics	- Transformative Characteristics	There is only one factor 'transformative characteristics' that emerges from both the sectors.

Out of the six second-order factors from the manufacturing sector and eight from the services sector, there are only three similar factors and the rest are different, which accounts for at least 60% difference (considering that there is a possibility to have a maximum of 8 second-order factors). Therefore, there is a difference between the manufacturing and services sectors in the second-order factor structure emerged from firms' activities within NIS.

4.7. Research Findings

This section summarises and discusses the results of hypothesis 1 that investigated research issue 1 by exploring the existence of hierarchical factor structures of NIS in the observation of firms' activities.

4.7.1. Summary of Findings

Research question 1, the associated main hypothesis and sub-hypotheses are presented in table 4.18 with the results and a general remark on contribution to theory.

Table 4.18: Summary of Findings for Research Question 1

Research Questions		Research Hypotheses		Conclusion	Contribution
RQ 1.0:	**What are the prevalent dimensions of NIS regarding firm attributes and their contexts? How do these dimensions differ between manufacturing and services sectors?**	**$H_{1.0}$:**	**There exists an underlying hierarchical factor structure (latent constructs) of the firm and national context related dimensions in the observations of firms' innovation activities within NIS.**	**There are valid and sound first- and second-order factors of NIS emerged from both Manufacturing and Services sectors. There are differences between the two sectors.** **Therefore, $H_{1.0}$ is supported.**	**A significant contribution to theory and practice.**
rq1.1:	What are the prevalent dimensions of NIS regarding firm attributes and their contexts in the manufacturing sector	$H_{1.1}$:	There exists an underlying two-level factor structure of the firm and national context related dimensions in the observations of firms' innovation activities in manufacturing sector within NIS.	15 valid and sound factors are observed in firms' activities as the first-order dimensions of NIS to explain the national innovation outcomes from the manufacturing sector. Six valid and sound factors are observed in firms' activities as second-order dimensions of NIS to explain the national innovation outcomes from the manufacturing sector. Therefore, $H_{1.1}$ is supported.	
rq 1.2:	What are the prevalent macro dimensions of NIS regarding firm attributes and their contexts in service sectors?	$H_{1.2}$:	There exists an underlying two-level factor structure of the firm and national context related dimensions in the observations of firms' innovation activities in services sector within NIS.	17 valid and sound factors are observed in firms' activities as first-order dimensions of NIS to explain the national innovation outcomes from the services sector.	

'Table 4.18, continued'.

	Research Questions		Research Hypotheses	Conclusion	Contribution
				Eight valid and sound factors are observed in firms' activities as second-order dimensions of NIS to explain the national innovation outcomes from the services sector. Therefore, $H_{1.2}$ is supported.	
rq 1.3:	How do the dimensions of NIS regarding firm attributes and their contexts differ between manufacturing and services sectors?	$H_{1.3}$:	Firm and context related dimensions within NIS differ between manufacturing and services sectors.	The manufacturing and services sectors are different regarding the first- and second-order patterns emerging from them. Therefore, $H_{1.3}$ is supported.	

4.7.2. Discussion of Findings

This section discusses the results of hypothesis 1 that explored the hierarchical factor structure of the dimensions of the NIS within its broad constituents 'national contexts' (Carlsson, Jacobsson, Holmén, & Rickne, 2002; Edquist & Hommen, 2008) and 'firms' (Lundvall, 2007; Whitley, 2007; Weber & Rohracher, 2012). Based on the discussions of Dopfer and Potts (2009) and Bleda and Del Río (2013), this study hypothesises the generic structure of the dimensions of NIS to be emerging as two-level constructs that are composed of a 'deep' (micro) level of ideas or generic rules, and of a 'surface' (macro) level composed of their actualisations in carriers. Based on the discussions of Pavitt (1984), Dosi et al., (1995), Malerba and Orsenigo (1997), Malerba (2002), and Arundel, Lorenz, Lundvall, and Valeyre (2007) this study further added to the hypothesis that the emerging two-level constructs are different between manufacturing and services sectors.

4.7.2.1. Research Issue 1.1

The findings for the ***sub-research issue 1.1, 'what are the prevalent dimensions of NIS regarding firm attributes and their contexts in the manufacturing sector?***' are presented below in table 4.19.

Table 4.19: Dimensions of NIS – Manufacturing Sector

No	Macro view (second-order) Dimensions from the Literature	Factor Structure with Macro view	No	Micro view (first-order) Dimensions from the Literature	Factor Structure with Micro-view
		Firms' Environments or National Contexts			
1	Infrastructure	• Infrastructure and Institution for Private Sources • Public and Other Funding Infrastructure	1	Knowledge Infrastructure	Knowledge Infrastructure for Information
2	Institution	Government Support Infrastructure and Institution	2	Technology Infrastructure	Technical Support Infrastructure
3	Market Factors	Market Knowledge Factor	3	Physical Infrastructure	
			4	Funding Infrastructure	• Private Funding Infrastructure • Public Funding Infrastructure
			5	Communication Infrastructure	
			6	Socio-technology Infrastructure	
			7	Financial Institution	Public Institution (Financial Institution)
			8	Labour Institution	
			9	Intellectual Property Protection	Intellectual Property Protection
			10	Information Asymmetries	Information Asymmetries
			11	Knowledge Spillover	
			12	Externalisation of Costs	
			13	Overexploitation of Commons	
		Firms or Firms' Attributes			
1	Capabilities	Capability (includes cooperation)	1	Internal Capability	• Internal Resources Capability • Financial Capability
2	Interactions (Cooperation)		2	External Capability	Externally Acquired Capability
3	Transformational Factors	Transformative Actions	3	Collaboration with Public Sciences	Cooperation
			4	Inter-firm Collaboration	
			5	Directionality	• Organisational Directionality • Financial Directionality
			6	Demand Articulation	Demand Articulation
			7	Notions of Coordination	Notion of Coordination
			8	Reflexivity	

From table 4.19, it is evident that five second-order (macro) factors emerged from the data out of the six proposed and eleven out of the twenty-one second-order (micro) factors emerged. Some dimensions segregated within and therefore resulted in six second-order and fifteen first-order factors in the manufacturing sector. There are three previous studies (Leiponen & Drejer, 2007; Srholec & Verspagen, 2008; Chaminade et al., 2012) that attempted to unravel dimensions in two different levels from the innovation surveys reflecting firms' perspectives on innovation. The following table compares the findings with the similar studies using innovation survey data by Leiponen and Drejer (2007) for Finland and Denmark, Srholec and Verspagen (2008) for thirteen European countries and Chaminade et al., (2012) for Thailand. The surface level (second-order) measures are compared first in table 4.20 and discussed followed by deep level (first-order) measures (refer to Appendix D-1 for comparison).

Table 4.20: Second-order measures of NIS of Manufacturing Sector compared to Previous Studies

No	Proposed second-order (macro) measures of NIS from literature	Second-order (macro) measures for manufacturing sector from this research	Second-order (macro) measures from (Leiponen & Drejer, 2007)	Second-order (macro) measures from (Srholec & Verspagen, 2008)	Second-order (macro) measures from (Chaminade, Intarakumnerd, & Sapprasert, 2012)
	Context-Related				
	Infrastructure	• Infrastructure and Institution for Private Sources * • Public and Other Funding Infrastructure	• Science-Based Firms (covering firms' capability, Public Knowledge Infrastructure and Collaboration with Public Sciences and Institution regarding IPP)***	Research (includes items such as R&D activities, public knowledge infrastructure, IPP and cooperation) ***	• Knowledge Resource (technology infrastructure and labour institutions) * • Telecommunication Infrastructure and Financial Institutions*
	Institution	Government Support Infrastructure and Institution*			Regulations other Institutional Conditions (covers institutions, funding infrastructure and organisational directionality) ***
	Market Factors	Market Knowledge Factor			
	Firm-Related				
	Capabilities	Capability (includes cooperation)	• Market Driven Firms (with a focus on internal knowledge, with an organisational directionality to be open and to extend)	External Inputs (regarding the use of external resources and suppliers & events knowledge infrastructure) **	
			•		

No	Proposed second-order (macro) measures of NIS from literature	Second-order (macro) measures for manufacturing sector from this research	Second-order (macro) measures from (Leiponen & Drejer, 2007)	Second-order (macro) measures from (Srholec & Verspagen, 2008)	Second-order (macro) measures from (Chaminade, Intarakumnerd, & Sapprasert, 2012)
	'Table 4.20, continued'.				
	Interactions (Cooperation)		Supplier Dominated Firms (look into Supplier Knowledge Infrastructure, cooperation with suppliers and clients)		Technical Support (this covers support through cooperation)
	Transformational Factors	Transformative Actions	Production Intensive Firms (look into labour, inputs and directionality regarding extension and openness) **	• User Orientation (includes marketing, client & industry infrastructure and non-technological innovation) ** • Production (involves process effects and social responsibilities)	Openness to Innovation (focusing directionality and demand regarding the openness of customers and suppliers)

Note: * indicates that the particular factor involves more than one context related indicators; ** indicates that the particular factor involves contextual and firm-related indicators; *** indicates that the particular factor involves both infrastructure & institution related indicators and contextual & firm related indicators; **** indicates that the particular factor involves more than one firm related indicators.

The findings related to hypothesis 1.1 contribute to five important interpretations of macro and micro patterns in the manufacturing sector of an emerging economy.

Firstly, NIS that exist in the manufacturing sector of the context of an emerging economy is composed of six dimensions at the macro (surface) level as carriers of innovation outcomes and 15 dimensions at the micro (deep) level as perceived ideas or rules that explain the innovation outcomes. Data from the manufacturing sector showed traces of all the six macro dimensions of NIS proposed based on the literature. Patterns of 'physical infrastructure', 'communication infrastructure', 'socio-technology infrastructure', 'labour institution', 'knowledge spillover', 'externalisation of costs', 'overexploitation of Commons' and 'reflexivity' are not apparent. Either there are no apparent patterns of these elements of NIS in the research context, or the indicators of these dimensions are insufficiently covered.

Secondly, the national contextual aspect of NIS consists of infrastructure, institution and market factors at the macro level as carriers of actualisation. However, 'infrastructure' is segregated into infrastructure for private and public sources and further skewed to knowledge and funding; 'institution' dimension is skewed to 'government support'; and 'market factor' is focused on knowledge. NIS at the deep (micro) level consists of six (knowledge infrastructure, technology infrastructure, funding infrastructure, financial institution, intellectual property protection and information asymmetries) dimensions out of the 13 proposed. The actual factor structure shows evidence of the segregation of funding infrastructure regarding 'private funding infrastructure' and 'public funding infrastructure'.

Thirdly, the factor structure of firm attributes of NIS is composed of two out of the three proposed dimensions ('capability' and 'transformative actions') at the macro view as carriers of actualisation. However, 'capability' dimension subsumed the 'cooperation' aspects. The pattern of microstructures of NIS showed a composition of seven out of the eight dimensions except for reflexivity. The actual factor structure shows evidence of the segregation of 'internal capability' into 'resource capability' and 'financial capability', and 'directionality' into 'organisational directionality' and 'financial directionality'. However, 'collaboration with public sciences' and 'inter-firm collaboration' combine into one-dimension 'cooperation'.

Fourthly, when the macro measures of the manufacturing sector are compared with similar studies (Leiponen & Drejer, 2007; Srholec & Verspagen, 2008; Chaminade et al., 2012) as indicated in table 4.20, it is evident that the findings are in alignment in terms of 'infrastructure', 'institution' and 'transformative actions'. This comparison indicates the similarity between developed and emerging economies in the patterns of NIS at the surface (macro) level. The findings of this study are also in alignment with the three previous studies in showing patterns of infrastructure and institutions dimensions that are overlapping, which indicates similar patterns of infrastructure and institution in developed and emerging economies from the perception of firms. Wieczorek and Hekkert (2012, p.77) also highlighted this in the scholarly discussions indicating that 'infrastructure does not have a steady position as a structural element of innovation systems and there is no conclusive agreement in the key literature positions as to what the term infrastructure covers'. Interestingly, a few authors such as Kuhlmann and Arnold (2001) and Schmoch, Rammer and Legier (2006) use the term 'infrastructure' for what is considered as 'institutions' in general. O'Sullivan (2005) uses the term 'infrastructure' to refer to what is considered institutions related to finance. In all the studies mentioned above, knowledge related infrastructure and institutions are apparent, which indicates that firms perceive knowledge related support from the national context quite prominently as the carrier of the actual outcome. However, the findings are aligned with Chaminade et al. (2012) in the patterns of 'government support infrastructure and institution' skewing to funding. These findings indicate that firms in emerging economies perceive the need for funding support to realise innovation, which is not the case with developed economies. This study also picked up different dimensions for private and public sources regarding infrastructure and institution, which is not the case with the other three studies. This finding indicates that the private and public sectors behave differently in dealing with innovation. This study also picked up patterns of 'market knowledge factors', which the previous studies did not have.

This study showed patterns of 'capability' (that includes the cooperation aspect) and 'transformative actions' in firm-related factors. The 'capability' dimension is in alignment with other studies done in developed economies by Leiponen and Drejer (2007) and Srholec and Verspagen (2008). However, the study done by Chaminade et al. (2012) did not pick up this factor in their study. The 'cooperation' dimension is more towards suppliers in Leiponen and Drejer (2007) and technical support through cooperation in Chaminade et al. (2012). There are differences in the macro measures of NIS between developed and emerging economies from firms' views when the manufacturing sector's data is scrutinised for patterns of NIS.

Fifthly, when the micro measures for the manufacturing sector are compared with the three similar previous studies, it is evident that the findings are in alignment with the similar studies regarding 'knowledge infrastructure', 'IPP', 'cooperation' and 'directionality'. These measures indicate the similarity between developed and developing countries in the patterns of NIS. However, certain measures derived from this study are only aligned with Chaminade et al. (2012) and are 'technical support infrastructure', 'funding infrastructure', and 'demand articulation'. These findings indicate that these micro measures of NIS are unique to emerging economies. Apart from these, 'information asymmetries', 'capability' and 'notion of coordination' also emerge from the data and are in line with the proposed measures based on the literature. However, patterns of 'capability' dimension are seen in other studies done in developed economies.

The findings confirm that there are valid and sound two-level dimensions of national contexts and firm attributes explaining NIS in the manufacturing sector. However, these dimensions established some differences from the proposed dimensions and developed economies. Some of the factors emerged also differ by segregating or combining with others. The dimension that did not emerge do not necessarily indicate that the dimensions do not exist; they may not be appropriately represented in the survey instrument. The following section discusses the summary of findings of research issue 1.2.

4.7.2.2. Research Issue 1.2

The findings for the ***sub-research issue 1.2, 'what are the prevalent dimensions of NIS regarding firm attributes and their contexts in services sector?***' are presented below in table 4.21.

Table 4.21: Dimensions of NIS – Services Sector

No	Macro view (second-order) Dimensions from the Literature	Factor Structure with Macro view	No	Micro view (first-order) Dimensions from the Literature	Factor Structure with Micro-view
		Firms' Environments or National Contexts			
1	Infrastructure	Knowledge Infrastructure Funding Infrastructure	1	Knowledge Infrastructure	Industry / Professional Knowledge Infrastructure Business Knowledge Infrastructure Scientific Knowledge Infrastructure
2	Institution	Government Support Infrastructure and Institution	2	Technology Infrastructure	Technical Support Infrastructure
3	Market Factors	Market Knowledge Factor	3	Physical Infrastructure	
			4	Funding Infrastructure	Private Funding Infrastructure Public and Other Funding Infrastructure
			5	Communication Infrastructure	
			6	Socio-technology Infrastructure	
			7	Financial Institution	Public Institution (Financial Institution)
			8	Labour Institution	
			9	Intellectual Property Protection	Intellectual Property Protection
			10	Information Asymmetries	Information Asymmetries
			11	Knowledge Spillover	
			12	Externalisation of Costs	
			13	Overexploitation of Common	

No	Macro view (second-order) Dimensions from the Literature	Factor Structure with Macro view	No	Micro view (first-order) Dimensions from the Literature	Factor Structure with Micro-view
	'Table 4.21, continued'.				
		Firms or Firms' Attributes			
1	Capabilities	Resource Capability	1	Internal Capability	Internal Resources Capability
		Financial Capability			Financial Capability
2	Interactions (Cooperation)	Cooperation	2	External Capability	Externally Acquired Capability
3	Transformational Factors	Transformative Actions	3	Collaboration with Public Sciences	Scientific Knowledge Cooperation
			4	Inter-firm Collaboration	Inter-firm Cooperation
			5	Directionality	Resource Directionality
					Financial Directionality
			6	Demand Articulation	Demand Articulation
			7	Notions of Coordination	
			8	Reflexivity	

From table 4.21, it is evident that all six proposed second-order (macro) factors and twelve out of the twenty-one second-order (micro) factors emerged from the data. Some dimensions segregated within and therefore resulted in eight second-order and seventeen first-order factors in the services sector. The following table compares the findings with the similar studies using innovation survey data by Leiponen and Drejer (2007) for Finland and Denmark, Srholec and Verspagen (2008) for thirteen European countries and Chaminade et al., (2012) for Thailand. The higher-order measures are compared and discussed first in Table 4.22 followed by lower-order measures (refer to Appendix D-2 for comparisons).

Table 4.22: Second-order measures of NIS of Services Sector compared to Previous Studies

No	Proposed second-order (macro) measures of NIS from literature	Second-order (macro) measures for manufacturing sector from this research	Second-order (macro) measures from (Leiponen & Drejer, 2007)	Second-order (macro) measures from (Srholec & Verspagen, 2008)	Second-order (macro) measures from (Chaminade, Intarakumnerd, & Sapprasert, 2012)
	Context-Related				
1	Infrastructure	Knowledge Infrastructure Funding Infrastructure	• Science-Based Firms (covering firms' capability, Public Knowledge Infrastructure and Collaboration with Public Sciences and Institution regarding IPP)*** • Supplier Dominated Firms (look into Supplier Knowledge Infrastructure, cooperation with suppliers and clients) **	Research (includes items such as R&D activities, public knowledge infrastructure, IPP and cooperation) ***	• Knowledge Resource (technology infrastructure and labour institutions) * • Telecommunication Infrastructure and Financial Institutions*
2	Institution	Government Support Infrastructure and Institution			Regulations other Institutional Conditions (covers institutions, funding infrastructure and organisational directionality) ***
3	Market Factors	Market Knowledge Factor			
	Firm-Related				
4	Capabilities	Resource Capability Financial Capability	Market Driven Firms (with a focus on internal knowledge, with an organisational directionality to be open and to extend)	External Inputs (regarding using external resources and suppliers & events knowledge infrastructure) **	
5	Interactions (Cooperation)	Cooperation			Technical Support (this covers support through cooperation)
6	Transformational Factors	Transformative Actions	Production Intensive Firms (look into labour, inputs and directionality regarding extension and openness) **	• User Orientation (includes marketing, client & industry infrastructure and non-technological innovation) ** • Production (involves process effects and social responsibilities)	Openness to Innovation (focusing directionality and demand regarding the openness of customers and suppliers)

Note: * indicates that the particular factor involves more than one context related indicators; ** indicates that the particular factor involves contextual and firm-related indicators; *** indicates that the particular factor involves both infrastructure & institution related indicators and contextual & firm related indicators; **** indicates that the particular factor involves more than one firm related indicators.

The findings related to hypothesis 1.2 contribute to five important interpretations of macro and micro patterns in the services sector of an emerging economy.

Firstly, the NIS of the services sector in the context of an emerging economy is composed of eight macros (surface) level dimensions that are the movers of innovation outcomes and seventeen deep (micro) dimensions that are perceived ideas or rules of the game that explain the innovation outcomes. All six proposed second-order (macro) factors emerged from the data, and twelve out of the twenty-one first-order (micro) factors emerged.

Secondly, the contextual aspect of NIS of services sector is composed of all the three dimensions (infrastructure, institution and market factors) proposed in the macro view (second-order). However, 'infrastructure' is segregated into knowledge and funding infrastructure; 'institution' dimension is skewed to 'government support'; and 'market factor' is focused on knowledge. Services sector showed differences in the emergence of factor structure for 'infrastructure dimension' at the macro view. At the deep (micro) level, NIS is composed of six (knowledge infrastructure, technology infrastructure, funding infrastructure, financial institution, intellectual property protection and information asymmetries) out of the 13 dimensions proposed based on the literature similar to the manufacturing sector. However, both knowledge and funding infrastructures showed segregation, unlike manufacturing sector where only funding infrastructure showed segregation.

Thirdly, the firm related constituent of NIS is composed of three dimensions ('capability', 'cooperation' and 'transformative actions') at the macro view (second-order). However, 'capability' dimension segregates into 'resource' and 'financial' capability, which is different from the manufacturing sector in which the 'capability' dimension subsumes the 'cooperation' aspects and become one. The firm related constituent of NIS of services sector at the micro view consists of seven dimensions except 'notion of coordination' and 'reflexivity' from the proposed dimensions. However, some of the dimensions ('internal capability' and 'directionality') differ from the proposed dimensions by segregating into more than one ('internal capability' into 'resource capability' and 'financial capability'; 'directionality' into 'resource directionality' and 'financial directionality') or a few ('collaboration with public sciences' and 'inter-firm collaboration') combining into one ('cooperation').

Fourthly, the findings of this study show distinct dimensions of infrastructure and institutions unlike the previous studies and the findings of the manufacturing sector. NIS pattern unravelled from services sector shows 'knowledge infrastructure', 'cooperation' and 'transformative actions' in alignment with all the three previous similar studies mentioned in table 4.22, which shows that firms in both developed and emerging economies view these macro dimensions prominently. However, the findings are aligned with Chaminade et al. (2012) and manufacturing sector in unravelling the macro dimensions 'institutions' and 'cooperation'. 'Capability' is picked up both in services and manufacturing and this is in alignment with studies from developed economies by Leiponen and Drejer (2007) and Srholec and Verspagen (2008), but not with Chaminade et al., (2012). The findings are aligned with Chaminade et al. (2012) in the patterns of funding infrastructure and institution, indicating that the firms require contextual support in these aspects. This study also unravelled an additional dimension related to the market for both manufacturing and services, which is not present in other similar studies.

Fifthly, NIS pattern unravelled at the micro level from services sector consists of 'knowledge infrastructure', 'intellectual property protection', 'collaboration with public sciences' and 'directionality' and are in alignment with all the other three studies, which shows that these micro dimensions are perceived important by firms in both developed and emerging economies. However, the findings are aligned with Chaminade et al. (2012) and manufacturing sector in unravelling the micro dimensions 'technological infrastructure', 'funding infrastructure', 'financial institution' and 'demand articulation', which indicates the possible unique dimensions of NIS of developing countries. 'Internal Capability' and 'external capability' emerged in both the services and manufacturing sectors and this is in alignment with studies from developed economies by Leiponen and Drejer (2007) for 'internal capability' and Srholec and Verspagen (2008) for both but not with Chaminade et al., (2012). This study also unravelled an additional dimension related to market 'information asymmetries' both for manufacturing and services, which is not present in other similar studies.

There are differences in the micro measures of NIS between developed and emerging economies from firms' views when the services sector's data is scrutinised for patterns of NIS. The following section summaries and discusses the findings of research issue 1.3.

4.7.2.3. Research Issue 1.3

The findings for the ***sub-research issue 1.3, 'How the dimensions of NIS regarding firm attributes and their contexts do differ between manufacturing and services sectors?***' are presented in figures 4.1 and 4.2.

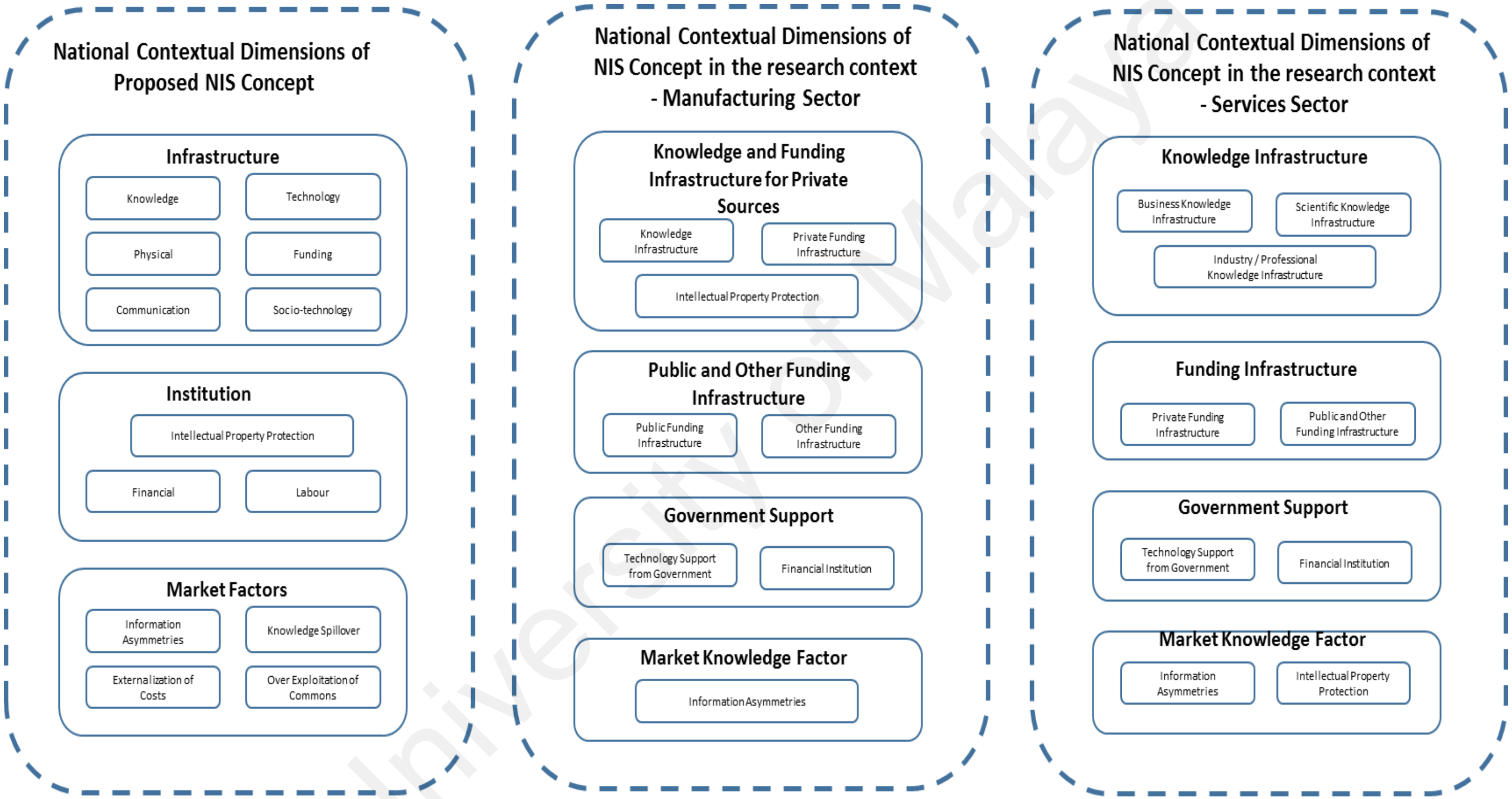

Figure 4.1: Comparison of Proposed National Contextual Dimensions of NIS with Dimensions unravelled from Manufacturing and Services

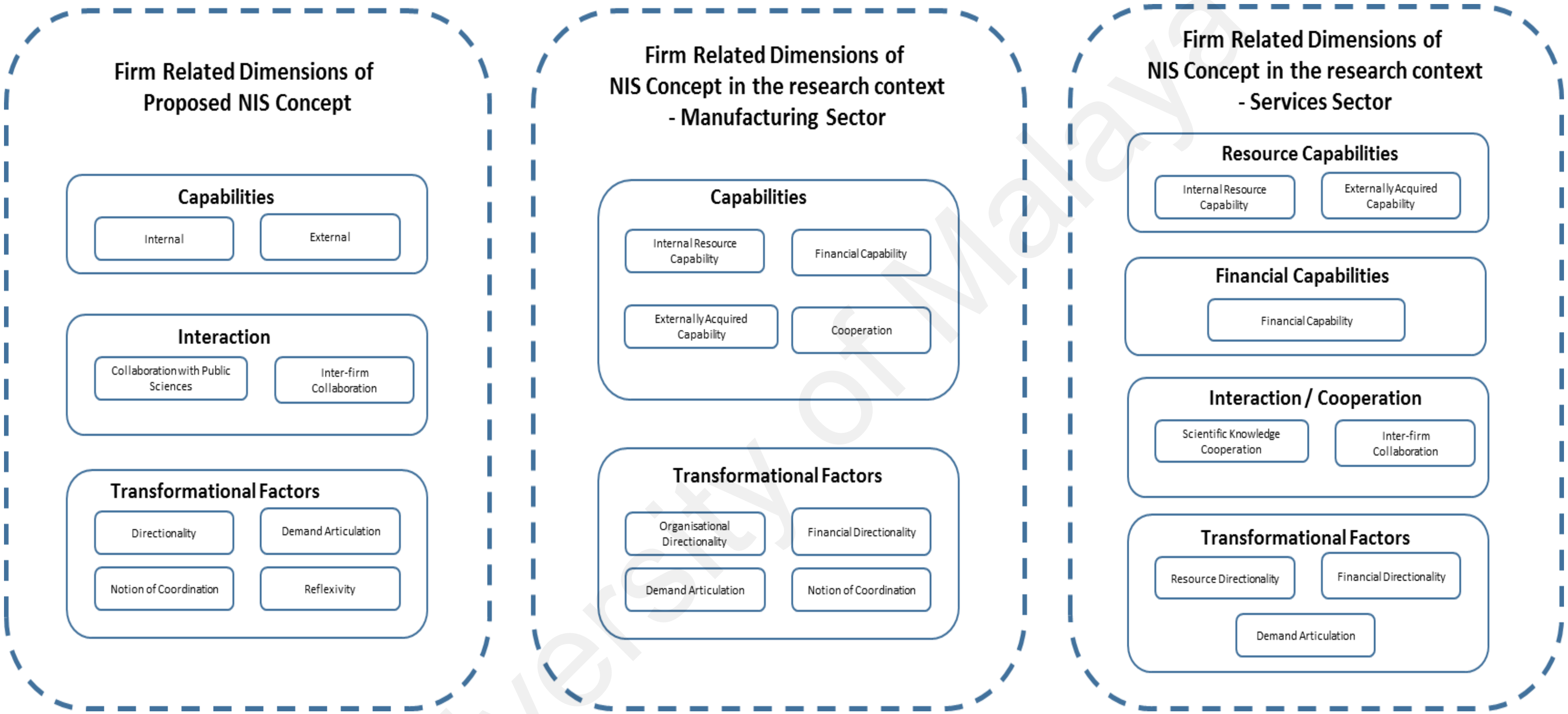

Figure 4.2: Comparison of Proposed Firm Related Dimensions of NIS with Dimensions unravelled from Manufacturing and Services

The following interpretations can be made from comparing the patterns of NIS in manufacturing and services sectors.

Firstly, both the sectors differ regarding the composition of some macro dimensions in explaining their innovation outcomes. While there are six macro dimensions play the role of carriers in realising the innovation outcomes in the manufacturing sector, there are eight dimensions in the services sector. Only three of them are similar while the rest are different. Among the three factors, two of them represent 'national contexts' namely, 'government support infrastructure and institution' and 'knowledge market factor'. One of them represents 'firm attributes' regarding 'transformative characteristics'. The similarity implies that these dimensions play a similar role in explaining innovation outcomes in both the sectors. However, both the sectors differ in the emerging patterns of institutions, infrastructure, capability and cooperation.

Both the sectors also differ in the composition of NIS regarding macro-level factors with 15 for the manufacturing sector and 17 for services sector explaining innovation outcomes. Among them, 10 of them are similar. These include four constructs representing 'national contexts' (public institution, intellectual property protection, government technical support and information asymmetries) and six representing 'firm attributes' (internal resource capability, externally acquired capability, financial capability, demand articulation, organisational capability and resource capability). Both the sectors differ mainly in 'infrastructure', 'capability' and 'cooperation' aspects at the micro-level.

Secondly, there are differences in firms' perception of 'infrastructure' and 'institution' in the contextual aspects of NIS. Services sector distinguishes between 'infrastructure' and ‘institution’. The ‘infrastructure’ dimension’ is further distinguished as ‘knowledge’ and ‘funding’ infrastructure. However, in the manufacturing sector, infrastructure and institution aspects combine and emerge as infrastructure and institution for ‘private sources’ and ‘public sources’. ‘Government support infrastructure and institution’ emerged as one of the factors for both sectors. There is an additional factor ‘infrastructure and institution for private sources’ observed in the manufacturing sector. In both the sectors, the institutional dimension is not distinct; it is integrated with certain elements of infrastructure. However, the constructs in manufacturing sectors are specific to public or private. Considering the dimension ‘infrastructure’, both the sectors distinctly differ. ‘Public funding infrastructure’ is obvious in the manufacturing sector. However, two factors ‘knowledge infrastructure’ and ‘funding infrastructure’ (without distinguishing the source of funding) are obvious in the services sector. ‘Market knowledge factor’ emerged in both, but mainly focusing on information asymmetries.

At the micro (deep) level, four dimensions representing ‘national contexts’ (public institution, intellectual property protection, government technical support and information asymmetries) are similar between the sectors. Both the sectors differ mainly in ‘infrastructure’ aspect in the national context. Considering ‘infrastructure’, both the sectors show obvious patterns of knowledge, funding and government technical support infrastructures. However, similar patterns exist only regarding ‘government technical support’. ‘Knowledge infrastructure’ emerges as a single factor in manufacturing, but segregates into three different types ‘industry knowledge’, ‘business knowledge’ and ‘scientific knowledge’ infrastructure in the services sector.

Thirdly, there are differences in firms’ perception of ‘capability’ and ‘cooperation’ in firm-related aspects of NIS between the sectors. ‘Capability’ (that includes all types of capabilities and interaction elements) emerges as the only factor from the data for the manufacturing sector. 'Capability' aspect of the services sector segregated into two different dimensions namely 'resource capability' and 'financial capability'. 'Cooperation' dimension emerges separately. However, in the manufacturing sector, there is no segregation, and both capability and cooperation aspects emerge as one. All these indicate that the role of capability and cooperation in realising innovation outcomes is perceived differently by the sectors.

The sectors differ mainly on 'capability' and 'cooperation' aspects at the micro-level. It is also noted here that 'co-operation' emerges as a single factor in the manufacturing sector while it segregates into two factors 'inter-firm cooperation' and 'scientific-knowledge cooperation' in the services sector. All constructs emerged are the same for both sectors except 'notion of coordination' in 'transformational characteristics', which is not extracted as a fundamental factor structure in the services sector. When the sectors are compared, both the sectors perceive funding infrastructure as segregated into 'private' and 'public' funding infrastructure, capability aspect as 'internal resource capability' and 'financial capability' and directionality aspect as 'organisational' and 'financial' directionality. However, they differ in knowledge infrastructure and cooperation aspects. While in manufacturing sector these aspects emerge as one; in services, knowledge infrastructure aspect segregate as 'industry', 'business' and 'scientific' knowledge infrastructure; and cooperation aspect into 'scientific knowledge' and 'inter-firm' cooperation.

There are differences in the macro measures of NIS between developed and emerging economies from firms' views when both the sectors are scrutinised for patterns of NIS. The differences are mainly in the organisation of 'infrastructure' and 'capability' dimensions at the macro level. At the micro level, sectors differ regarding segregations in various dimensions such as knowledge and funding infrastructures, firms' capability and cooperation aspects.

It has been advocated by many over the years, as has been discussed above, that patterns of innovation are strongly related to industry, country and other contextual factors (Srholec & Verspagen, 2008). Although Leiponen and Drejer (2007) pointed to the problem of projecting the standard industrial classification (sectors) on the organisation of innovation activities, their analysis is inconclusive after taking into account sectoral patterns (Srholec & Verspagen, 2008) and the emerging economy context. This study extended understanding in this regard. A summary of the differences between the proposed dimensions against the dimensions unravelled from the data for both manufacturing and services sectors is presented in figures 4.1, 4.2, and a framework of NIS based on the unravelled dimensions in figure 4.3.

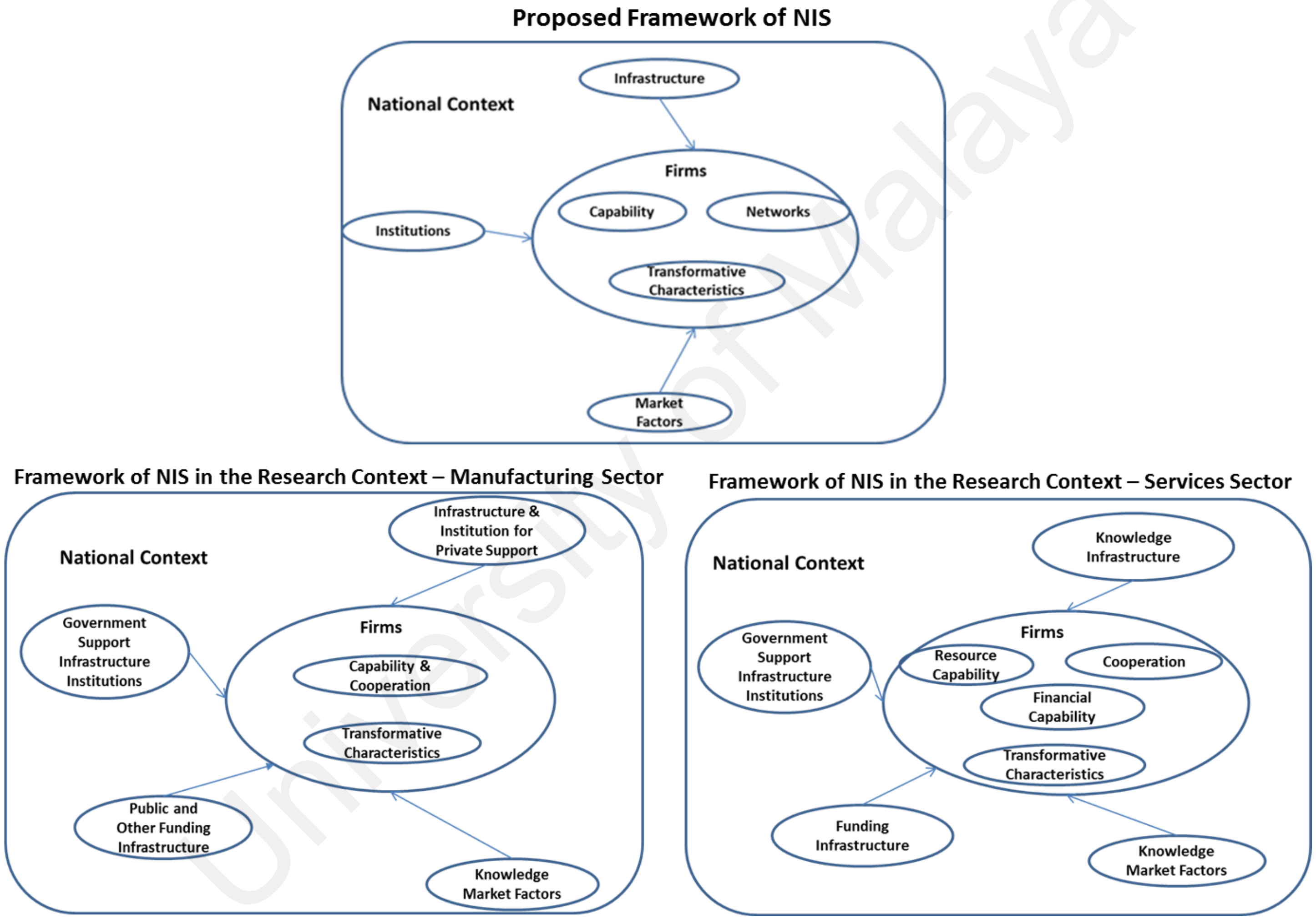

Figure 4.3: Proposed Versus the Actual Framework of NIS in the Research Context

The findings show similarities and differences compared to previous similar studies by Leiponen and Drejer (2007), Srholec and Verspagen (2008) and Chaminade et al. (2012), which are used to make comparisons between developed and emerging economies. Further, the findings also establish similarities and differences between the sectors. The following are the summary of the interpretations.

4.8. Summary

This chapter seeks to determine the hierarchical structure of NIS from firms' perspective by employing a hybrid method factor analytic model that involves multiple and second-order factor analyses. It is evident from the findings that there are differences in the dimensions of NIS between manufacturing and services sectors. In general, the first-order factor structure showed around 35% difference (considering that there is a possibility to have a maximum of 17 first-order factors) and second-order factor structure showed around 60% difference (considering that there is a possibility to have a maximum of 8 second-order factors) approximately. Therefore, there is a difference between the manufacturing and services sectors in the first-order factor structure emerged from firms' activities within NIS. It further shows that the differences increase when the view of NIS moves from micro (first-order) to macro (second-order) aspects between the sectors. It emphasises the importance to consider the differences.

In general, the findings establish valid and sound hierarchical factor structure of NIS for both manufacturing and services sectors that are different from each other regarding the patterns emerging from them. This study is a valid research attempt to authenticate the economic power of the microstructures that provide macro explanations of NIS in emerging economies. The results indicate that the dimensions of NIS that explain the national innovation outcomes of emerging economies differ in their patterns from the conceptual discussions of NIS that are based on developed economies. The patterns of NIS regarding its dimensions also differ between manufacturing and services sectors, which supports the sectoral perspectives of Breschi and Malerba (1997) and Lundvall (2007). In general, the findings confirm that there are valid and sound two-level dimensions of national contexts and firm attributes explaining NIS, which differ between manufacturing and services sectors and different in certain aspects of developed economies. The findings of the study also make it evident that the previous studies did not attempt to differentiate between context-related and film-related factors. This differentiation is a major contribution of this study. This distinction enables policymakers to work on the relevant dimensions of NIS.

CHAPTER 5: ASSESSING THE SYSTEMIC ENABLERS AND PROBLEMS IN THE NATIONAL INNOVATION SYSTEM

5.1. Introduction

This chapter analyses the findings of the second research objective. The objective is to empirically examine systemic problems and enablers in National Innovation System (NIS) of Malaysia regarding firm attributes and their contexts, which can be comprehensively managed to enhance innovation outcomes. This objective is investigated by exploring the direction of the effect of dimensions of NIS on innovation outcomes. The hypothesis associated with this objective is:

$H_{2.0}$: ***The dimensions (both first and second order) of NIS regarding firm attributes and their contexts have a significant effect on innovation outcomes.***

As discussed in the literature, firms are heterogeneous, and they differ based on sectors. Therefore, hypothesis 2 is tested in sub-hypotheses presented below:

$H_{2.1}$: *The dimensions (both first and second order) of NIS regarding firm attributes and their contexts have a significant effect on innovation outcomes in the manufacturing sector.*

$H_{2.2}$: *The dimensions of NIS (both first and second order) regarding firm attributes and their contexts have a significant effect on innovation outcomes in the services sector.*

$H_{2.3}$: There is a difference between manufacturing and services sectors in the direct influence of firm attributes and their contexts on innovation outcomes in NIS.

Examining the effect of first- and second order measures on innovation outcomes involve assessing the relationship between the measures and the innovation outcomes. Structural Equation Modelling (SEM) with Partial Least Square (PLS) approach is used as indicated in the methodology section. Analyses are performed using the SmartPLS 3.0 software. This section presents the outcome of the analysis. The outline of this section includes assessment of collinearity issue, significance and relevance of structural model relationships (for first-order and second-order models), the explanatory power of the model, assessment of effect size and assessment of predictive relevance for manufacturing and services sectors. The chapter concludes with a comparison between the sectors and summary of the findings.

5.2. Assessment of Structural (Inner) Model for Manufacturing Sector

The assessment of structural (inner) model requires reliable and valid measurement (outer) model estimates as per Henseler et al. (2009). The reliability and validity of the measurement model estimates are established and summarised in chapter 4. Based on that, the valid 15 first-order measures and six second-order measures are considered.

The evaluation of structural model is an act of comparing the constructs within the model as per Hanlon (2001), or it can be referred as an assessment of the statistical significance of the path loadings and path coefficient between each construct as per Barclay, Higgins, and Thompson (1995). Based on (Gefen et al., 2000), scholars of PLS use the bootstrap technique to test the relationship between variables. Mustamil (2010) suggested to using three criteria to assess the structural model and are (i) R square (R^2), which is traditionally called coefficient of determination; (ii) path coefficient (β); and (iii) the statistical significance of t-value. These criteria represent the percentage of variance explained, the strength of the relationships between constructs, and an indication of if the relationship between the constructs is significant or not respectively. However, Hair *et al.* (2013) suggested five steps for PLS-SEM structural model assessment and are Collinearity Issue Assessment; Assessment of Significance and Relevance of Paths; coefficient of determination (R^2) Assessment; Assessment of the Effect size (f^2), and assessment of the predictive relevance (Q^2) as indicated below in figure 5.1.

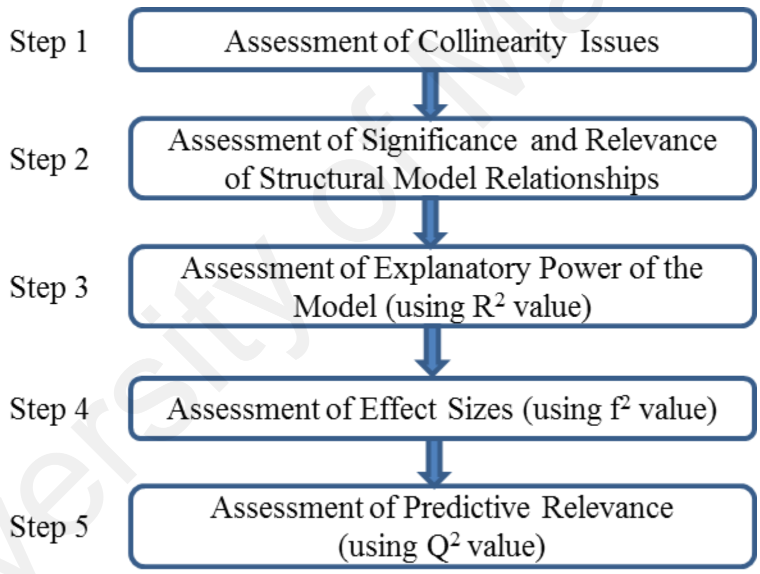

Figure 5.1: PLS-SEM Structural Model Assessment

Source: Hair et al. (2013, p. 169)

5.2.1. Assessment of Collinearity Issue

This research examined the collinearity issue using the correlation among exogenous variables, their VIF, and tolerance. Correlation matrix for exogenous variables in the models of first and second order measures are shown in Table 5.1 and 5.2. The correlation coefficient for the first-order measures range from -0.188 to 0.700 and second-order measures range from 0.013 to 0.579 are below 0.8, which indicate there is no high correlation among variables as per Field (2013).

Table 5.1: Correlation among the First-order Exogenous Variables

	Cooperation	Demand Articulation	External Resource Capability	Financial Capability (Own Source of Fund)	Government Technical Support Infrastructure	Information Asymmetries	Innovation Outcomes	Intellectual Property Protection	Internal Resource Capability	Knowledge Infrastructure (Strategic Info)	Notion of Cooperation	Organisational Directionality	Private Source of Fund	Public Funding Infrastructure	Public Institution	Resource Directionality
Cooperation	1.000															
Demand Articulation	-0.026	1.000														
External Resource Capability	0.323	0.018	1.000													
Financial Capability (Own Source of Fund)	0.188	0.010	0.266	1.000												
Government Technical Support Infrastructure	0.224	-0.139	0.154	-0.008	1.000											
Information Asymmetries	0.055	0.275	0.091	0.121	0.147	1.000										
Innovation Outcomes	0.262	-0.148	0.422	0.114	0.362	0.078	1.000									
Intellectual Property Protection	0.307	0.001	0.385	0.196	0.191	0.079	0.375	1.000								

‘Table 5.1, continued’.

	Cooperation	Demand Articulation	External Resource Capability	Financial Capability (Own Source of Fund)	Government Technical Support Infrastructure	Information Asymmetries	Innovation Outcomes	Intellectual Property Protection	Internal Resource Capability	Knowledge Infrastructure (Strategic Info)	Notion of Cooperation	Organisational Directionality	Private Source of Fund	Public Funding Infrastructure	Public Institution	Resource Directionality
Internal Resource Capability	0.244	-0.076	0.571	0.320	0.263	0.130	0.502	0.371	1.000							
Knowledge Infrastructure (Strategic Info)	0.624	-0.016	0.353	0.177	0.107	0.130	0.349	0.495	0.347	1.000						
Notion of Cooperation	0.023	0.350	0.082	0.136	0.076	0.640	0.217	0.185	0.279	0.180	1.000					
Organisational Directionality	0.039	0.368	0.139	0.110	0.095	0.605	0.187	0.280	0.266	0.137	0.700	1.000				
Private Source of Fund	0.065	0.001	0.292	0.077	-0.122	-0.023	0.148	0.235	0.260	0.296	0.223	0.132	1.000			
Public Funding Infrastructure	0.081	0.042	0.145	0.016	0.262	0.141	0.145	0.175	0.144	0.148	0.077	0.118	0.041	1.000		
Public Institution	0.272	-0.188	0.262	0.091	0.554	-0.051	0.471	0.306	0.385	0.231	0.081	0.143	0.215	0.313	1.000	
Resource Directionality	0.122	0.205	0.259	0.119	0.150	0.581	0.228	0.408	0.356	0.237	0.616	0.672	0.218	0.087	0.179	1.000

Table 5.2: Correlation among the Second-order Exogenous Variables

	Firms' Capability	Firms' Transformational Actions	Funding Infrastructure	Government Support Infrastructure and Institution	Infrastructure and Institution for Private Sources	Innovation Outcomes	Market Knowledge Factor
Firms' Capability	1.000						
Firms' Transformational Actions	0.335	1.000					
Funding Infrastructure	0.164	0.033	1.000				
Government Support Infrastructure and Institution	0.427	0.236	0.315	1.000			
Infrastructure and Institution for Private Sources	0.508	0.316	0.144	0.309	1.000		
Innovation Outcomes	0.579	0.373	0.110	0.490	0.500	1.000	
Market Knowledge Factor	0.131	0.505	0.129	0.013	0.114	0.037	1.000

As it is shown in Table 5.3 and Table 5.4, the VIF of variables for the first-order (varies between 1.190 and 2.760) and the second-order (varies ranges from 1.156 to 1.599) models are below five (Hair *et al.*, 2011; Myers, 1990). In addition, tolerance values for the first-order (varies between 0.362 and 0.840) and the second-order models (ranges from 0.625 to 0.865) are above 0.2 (Hair *et al.*, 2011; Menard, 1995).

Table 5.3: VIF and Tolerance Values for First-order Exogenous Variables

First-order Exogenous Variables	VIF	Tolerance
Cooperation	1.881	0.532
Demand Articulation	1.337	0.748
External Resource Capability	1.790	0.559
Financial Capability (Own Source of Fund)	1.190	0.840
Government Technical Support Infrastructure	1.771	0.565
Information Asymmetries	2.445	0.409
Intellectual Property Protection	1.754	0.570
Internal Resource Capability	1.984	0.504
Knowledge Infrastructure (Strategic Info)	2.257	0.443
Notion of Cooperation	2.760	0.362
Organisational Directionality	2.741	0.365
Private Source of Fund	1.465	0.683
Public Funding Infrastructure	1.215	0.823
Public Institution	2.054	0.487
Resource Directionality	2.530	0.395

Table 5.4: VIF and Tolerance Values for Second-order Exogenous Variables

	VIF	Tolerance
Firms' Capability	1.560	0.641
Firms' Transformational Actions	1.599	0.625
Funding Infrastructure	1.156	0.865
Government Support Infrastructure and Institution	1.387	0.721
Infrastructure and Institution for Private Sources	1.412	0.708
Market Knowledge Factor	1.412	0.708

Since there is no collinearity problem based on the findings, the predictor constructs are not biased. Once the collinearity issues are evaluated and cleared, the significance and relevance of the relationships as stipulated in the structural model are assessed to test the proposed hypotheses.

5.2.2. Significance and Relevance of Structural Model Relationships

This assessment is done using standardised path coefficients estimated by PLS algorithm. The PLS path modelling method was developed by Wold (1982), and the PLS algorithm is mostly a sequence of regressions regarding weight vectors. Subsequently, bootstrapping is run with 2000 replications to estimate the standard deviation of path coefficients, *t*-value and p-value for each path in their respective model. Bootstrapping is a nonparametric procedure that can be applied to test whether coefficients such as outer weights, outer loadings and path coefficients are significant by estimating standard errors for the estimates. The first-and second-order structural models' path coefficients, their significance and the decision on whether a particular measure is a systemic enabler or a problem (based on the direction of the relationship) are presented in tables 5.5 and 5.6.

Table 5.5: First-order Structural Model Path Coefficient (β) Sizes and Significance

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Enablers and Problems
Firm-Related Factors						
Internal Resource Capability -> Innovation Outcomes	0.196	0.191	0.058	3.395	0.001	Enabler***
External Resource Capability -> Innovation Outcomes	0.219	0.217	0.050	4.391	0.000	Enabler***
Financial Capability (Own Source of Fund) -> Innovation Outcomes	-0.075	-0.057	0.057	1.296	0.195	Problem
Cooperation -> Innovation Outcomes	-0.035	-0.033	0.055	0.645	0.519	Problem
Demand Articulation -> Innovation Outcomes	-0.128	-0.131	0.046	2.791	0.005	Problem***
Notion of Cooperation -> Innovation Outcomes	0.231	0.218	0.067	3.473	0.001	Enabler***
Organisational Directionality -> Innovation Outcomes	0.018	0.028	0.061	0.294	0.769	Enabler
Resource Directionality -> Innovation Outcomes	-0.095	-0.088	0.065	1.445	0.149	Problem
Contextual Factors						
Knowledge Infrastructure Technical Support (Government Technical Support Infrastructure) -> Innovation Outcomes	0.101	0.102	0.047	2.152	0.032	Enabler**
Public Institution -> Innovation Outcomes	0.242	0.241	0.057	4.265	0.000	Enabler***
Private Funding Infrastructure (Private Source of Fund) -> Innovation Outcomes	-0.102	-0.097	0.040	2.515	0.012	Problem**
Knowledge Infrastructure (Strategic Info) -> Innovation Outcomes	0.138	0.139	0.055	2.536	0.011	Enabler**
Intellectual Property Protection -> Innovation Outcomes	0.110	0.105	0.050	2.197	0.028	Enabler**
Public Funding Infrastructure -> Innovation Outcomes	-0.056	-0.048	0.029	1.939	0.053	Problem*
Information Asymmetries -> Innovation Outcomes	-0.049	-0.049	0.087	0.566	0.571	Problem

Note: * indicates significance at 90%, ** 95% and *** 99%

Out of the fifteen first-order measures, eight of them had positive path coefficients indicating that they were enablers of innovation outcomes. Seven of them returned with negative path coefficients indicting their hampering effect on innovation outcomes. Seven of the enablers (namely internal resource capability, external resource capability, the notion of cooperation, government technical support infrastructure, a public institution, knowledge infrastructure and intellectual property protection) had a significant positive relationship with Innovation outcomes. Among the seven measures that returned negative relationship, only three (demand articulation, private source of fund and public funding infrastructure) of them showed a significant negative relationship with Innovation outcomes. Among the significant enablers, a public institution is the strongest enabler based on the value of path coefficient followed by internal resource capability of firms and their notion of alignment. The biggest problem is the demand articulation followed by the private source of fund and public funding infrastructure. These results show evidence of seven systemic enablers and three systemic problems to result in innovation outcomes in the NIS at the micro level.

Considering the eight firm related factors, internal resource capability, external resource capability and the notion of alignment show a significant positive relationship with innovation outcomes, while their demand articulation shows a significant negative relationship with innovation outcomes. Considering the contextual factors, government technical support infrastructure, public institution, knowledge infrastructure and IPP show a significant positive relationship with firms' IOs while the private source of fund and public funding infrastructure show a negative relationship.

Table 5.6: Second-order Structural Model Path Coefficient (β) Sizes and Significance

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Enabler / Barrier
Firm Related Factors						
Firms' Capability -> Innovation Outcomes	0.315	0.316	0.052	6.064	0.000	Enabler***
Firms' Transformational Actions -> Innovation Outcomes	0.207	0.207	0.075	2.744	0.006	Enabler**
Contextual Factors						
Funding Infrastructure -> Innovation Outcomes	-0.043	-0.046	0.047	0.923	0.356	Barrier
Government Support Infrastructure and Institution -> Innovation Outcomes	0.254	0.256	0.053	4.838	0.000	Enabler***
Infrastructure and Institution for Private Sources -> Innovation Outcomes	0.217	0.227	0.048	4.501	0.000	Enabler***
Market Knowledge Factor -> Innovation Outcomes	-0.131	-0.128	0.061	2.142	0.032	Barrier**

Note: * indicates significance at 90%, ** 95% and *** 99%

The results of the second-order (macro-level) pattern showed evidence of four enablers (‘capability’, ‘transformational actions’, ‘Government support infrastructure and institution’ and ‘infrastructure and institution for private sources’) and one barrier (‘market knowledge factor’). However, literature suggested six dimensions at the macro-level. Firms’ ‘capability’ emerged as the strongest enabler followed by ‘government support infrastructure and institution’.

5.2.3. Explanatory Power of the Model

The explanatory power of the model is evaluated using the coefficient of determination (R^2). R^2 is used in statistical models with the objective to predict future outcomes or to test hypotheses. This coefficient is used to evaluate the predictive accuracy of the model and to assess how well the observed model fits the theoretical model. R^2 value shows the variance in the endogenous variable (innovation outcomes), which is explained by the exogenous variables in the model regressed to it. The PLS path modelling estimation using first-order measures for the manufacturing sector is shown in figure 5.2. Based on the diagram, the coefficient of determination, R^2, is 0.437 for the Innovation Outcomes (IO) endogenous latent variable, which indicates that the fifteen first-order latent variables moderately (43.7%) explain the variance in innovation outcomes (IO). The R^2 value satisfied the minimum requirement of the 10% cut off value and significant with substantial explanatory power indicating the predictive accuracy of the model for planning purposes.

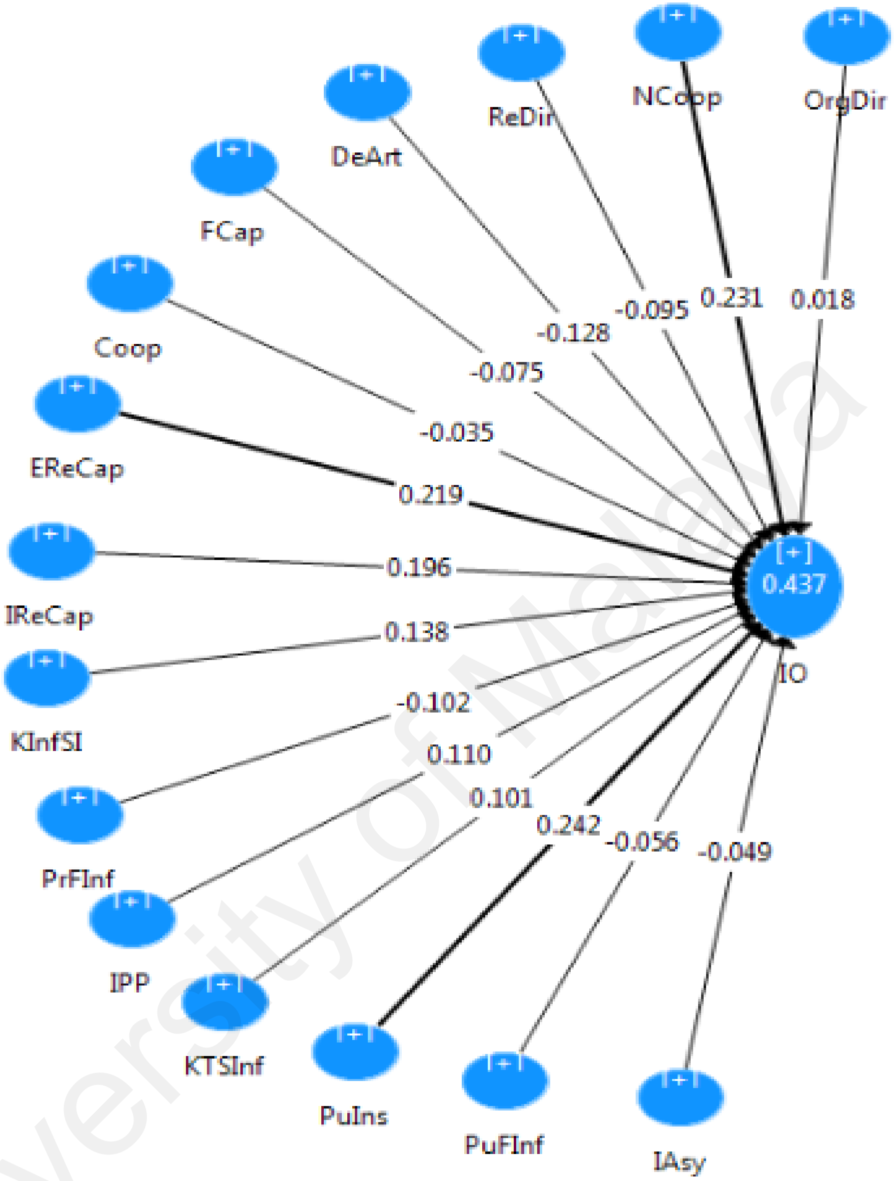

Figure 5.2: PLS First-order Structural Model for Manufacturing Sector

Legend: OrgDir – Organisational Directionality; Ncoop – Notion of Cooperation: ReDir – Resource Directionality; DeArt – Demand Articulation; FCap – Financial Capability; Coop - Cooperation: EReCap – External Resource Capability; IReCap – Internal Resource Capability; KInfSI – Knowledge Infrastructure (Strategic Information); PrFInf – Private Funding Infrastructure; IPP – Intellectual Property Protection; KTSInf – Knowledge Infrastructure (Government Technical Support); PuIns – Public Institution; PuFinf – Public Funding Infrastructure; IAsy – Information Asymmetries.

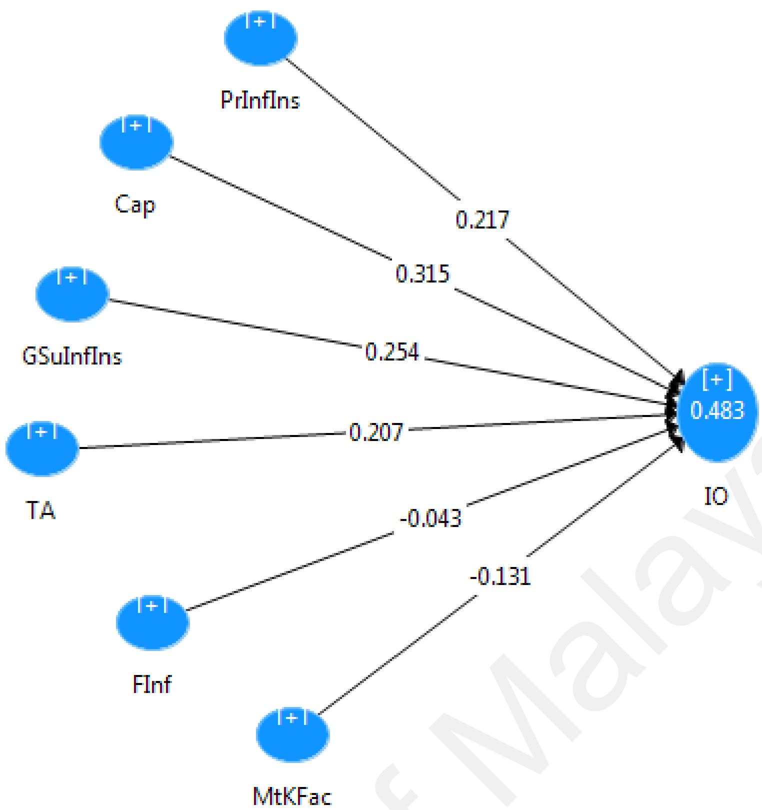

Figure 5.3: PLS Second-order Structural Model for Manufacturing Sector

Legend: PrInfIns – Private Infrastructure and Institution; Cap – Firms' Capability; GSuInfIns – Government Support Infrastructure and Institution; TA – Firms' Transformational Actions; Finf – Funding Infrastructure; MtKFac – Market Knowledge Factor.

The PLS path modelling estimation using second-order measures for the manufacturing sector is shown in figure 5.3. Based on the diagram, the coefficient of determination, R^2, is 0.483 for the Innovation Outcomes (IO) endogenous latent variable, which means that the six second-order latent variables moderately (48.3%) explain the variance in IO.

The findings showed that R^2 score of endogenous construct's (innovation outcomes) value satisfied the minimum requirement for the 0.10 cut off value, which had been the indication of a relatively parsimonious model as per (Hanlon, 2001; Mustamil, 2010). Above all, the variability explained by the endogenous constructs provided the model with a substantial nomological validity in the manufacturing sector of an emerging economy context of Malaysia, whereby large numbers of indifferent factors influence the ultimate dependent variable 'innovation outcomes'. However, the models (both first-order and second-order) specified here had sufficient merit as they explained about 43.7% and 48.3% respectively of the variance in the innovation outcomes of firms.

5.2.4. Assessment of Effect Size

Effect size is used to assess the strength of a phenomenon. Based on Fritz, Morris, and Richler (2012), estimates of effect size are useful for determining the practical or theoretical importance of an effect, the relative contribution of different factors or the same factor in different circumstances, and the power of analysis. In hypothetical models, the dependent and intervening variables are predicted by more than one predicting or intervening variable. According to Wong (2013), effect sizes as indicated as f^2 can be estimated to assess how much a predicting (exogenous) variable contributes to an endogenous latent variable's R^2 value by SmartPLS 3 bootstrapping procedure. The author also provided a rule of thumb indicating that f^2 value of 0.02 shows a small effect, f^2 value of 0.15 shows a medium effect, and f^2 value of 0.35 shows a large effect. The f^2 values estimated are presented below in Tables 5.7 and 5.8 for first- and second-order measures respectively.

Table 5.7: Effect Size for First-order Measures

	Original Sample (O)
Cooperation -> Innovation Outcomes	0.001 (small)
Demand Articulation -> Innovation Outcomes	0.022 (small)
External Resource Capability -> Innovation Outcomes	0.048 (small)
Financial Capability (Own Source of Fund) -> Innovation Outcomes	0.008 (small)
Government Technical Support Infrastructure -> Innovation Outcomes	0.010 (small)
Information Asymmetries -> Innovation Outcomes	0.002 (small)
Intellectual Property Protection -> Innovation Outcomes	0.012 (small)
Internal Resource Capability -> Innovation Outcomes	0.034 (small)
Knowledge Infrastructure (Strategic Info) -> Innovation Outcomes	0.015 (small)
Notion of Cooperation -> Innovation Outcomes	0.034 (small)
Organisational Directionality -> Innovation Outcomes	0.000 (small)
Private Source of Fund -> Innovation Outcomes	0.013 (small)
Public Funding Infrastructure -> Innovation Outcomes	0.005 (small)
Public Institution -> Innovation Outcomes	0.050 (small)
Resource Directionality -> Innovation Outcomes	0.006 (small)

Table 5.8: Effect Size for Second-order Measures

	Original Sample (O)
Firms' Capability -> Innovation Outcomes	0.123 (small)
Firms' Transformational Actions -> Innovation Outcomes	0.052 (small)
Funding Infrastructure -> Innovation Outcomes	0.003 (small)
Government Support Infrastructure and Institution -> Innovation Outcomes	0.090 (small)
Infrastructure and Institution for Private Sources -> Innovation Outcomes	0.065 (small)
Market Knowledge Factor -> Innovation Outcomes	0.024 (small)

From the tables, it is evident that mostly the effect sizes are small. However, all the predicting variables have contributed to the endogenous variable 'innovation outcomes'.

5.2.5. Assessment of Predictive Relevance

Predictive relevance indicates how accurately the model can predict innovation outcomes as an endogenous construct in the model. Based on Geisser (1974) and Stone (1974), the magnitude of the coefficient of determination as a criterion of predictive accuracy can be assessed using Stone-Geisser's Q^2 effect size. Based on Hair *et al.*, (2013), Q^2 is a measure of the predictive accuracy and relevance of the model. The two different methods available to estimate Q^2 value are the cross-validated redundancy, and the cross-validated communality approaches. While the cross-validated communality approach estimates the value using only the measurement model, cross-validated redundancy approach uses both path models of the structural model and the measurement model respectively. Hence, this research used the cross-validated redundancy approach to compute Stone-Geisser's Q^2 effect size as suggested by Chin (2010). A Q^2 greater than zero implies that the model has predictive relevance, whereas a Q^2 less than zero suggests that the model lacks predictive relevance (Chin, 1988). Blindfolding procedure in SmartPLS is used to estimate the Q^2 values and are presented in Table 5.9. Blindfolding is a sample re-uses technique that calculates a cross-validated predictive relevance criterion, the Stone-Geisser's Q^2 value (Stone, 1974; Geisser, 1974).

Table 5.9: Predictive Relevance for the Endogenous Dimension – Manufacturing Sector

	Q^2
First-order measures of Innovation Outcomes	0.140
Second-order measures of Innovation Outcomes	0.121

Since the Q^2 values of innovation outcomes for both first- and second-order measures are more than zero, both models have predictive relevance.

5.3. Assessment of Structural (Inner) Model for Services Sector

5.3.1. Assessment of Collinearity Issue

This research examined the collinearity issue using the correlation among exogenous variables, their VIF, and tolerance. Correlation matrix for exogenous variables in the models of first and second order measures are shown in Table 5.10 and 5.11. Correlation coefficients for the first-order measures range from -0.545 to 0.651 and second-order measures range from -0.226 to 0.499 are below 0.8, which indicate there is no high correlation among variables as per Field (2013).

Table 5.10: Correlation among the First-order Exogenous Variables

	Business Knowledge Infrastructure	Demand Articulation	External Resource Capability	Financial Institution	Industry Knowledge Infrastructure	Information Asymmetries	Innovation Outcomes	Intellectual Property Protection	Inter-firm Cooperation	Internal Resource Capability	Organisational Directionality	Own Source of Fund	Private Funding Infrastructure	Public and Other Funding Infrastructure	Resource Directionality	Scientific Knowledge Cooperation	Scientific Knowledge Infrastructure	Technical Support Infrastructure
Business Knowledge Infrastructure	1.000																	
Demand Articulation	-0.075	1.000																
External Resource Capability	0.004	0.036	1.000															
Financial Institution	0.059	0.007	0.063	1.000														
Industry Knowledge Infrastructure	0.097	0.017	-0.046	0.031	1.000													
Information Asymmetries	0.044	-0.522	0.046	-0.019	-0.065	1.000												
Innovation Outcomes	0.044	-0.046	0.410	0.063	-0.070	0.052	1.000											
Intellectual Property Protection	0.051	-0.259	0.098	0.011	-0.039	0.580	0.059	1.000										

‘Table 5.10, continued’.

	Business Knowledge Infrastructure	Demand Articulation	External Resource Capability	Financial Institution	Industry Knowledge Infrastructure	Information Asymmetries	Innovation Outcomes	Intellectual Property Protection	Inter-firm Cooperation	Internal Resource Capability	Organisational Directionality	Own Source of Fund	Private Funding Infrastructure	Public and Other Funding Infrastructure	Resource Directionality	Scientific Knowledge Cooperation	Scientific Knowledge Infrastructure	Technical Support Infrastructure
Interfirm Cooperation	0.240	-0.002	-0.053	0.055	0.651	-0.020	-0.041	0.000	1.000									
Internal Resource Capability	0.005	-0.040	0.488	0.069	-0.021	0.050	0.459	0.084	-0.016	1.000								
Organisational Directionality	0.065	-0.399	-0.009	0.009	-0.070	0.525	0.068	0.266	-0.016	-0.003	1.000							
Own Source of Fund	-0.027	-0.087	0.079	-0.050	-0.013	0.013	0.076	0.040	-0.013	0.093	0.096	1.000						
Private Funding Infrastructure	-0.002	0.031	0.059	-0.029	0.013	-0.003	0.078	0.045	-0.003	0.044	-0.030	0.165	1.000					
Public and Other Funding Infrastructure	0.008	-0.016	0.098	0.032	0.004	0.032	0.028	0.054	-0.061	0.035	-0.011	-0.098	0.094	1.000				
Resource Directionality	-0.018	-0.545	-0.019	-0.071	0.007	0.397	-0.030	0.396	-0.006	0.001	0.283	0.082	-0.012	-0.033	1.000			
Scientific Knowledge Cooperation	0.339	0.015	-0.052	0.120	0.379	-0.078	-0.022	0.016	0.567	-0.018	0.000	-0.074	-0.043	-0.051	0.004	1.000		

'Table 5.10, continued'.

	Business Knowledge Infrastructure	Demand Articulation	External Resource Capability	Financial Institution	Industry Knowledge Infrastructure	Information Asymmetries	Innovation Outcomes	Intellectual Property Protection	Inter-firm Cooperation	Internal Resource Capability	Organisational Directionality	Own Source of Fund	Private Funding Infrastructure	Public and Other Funding Infrastructure	Resource Directionality	Scientific Knowledge Cooperation	Scientific Knowledge Infrastructure	Technical Support Infrastructure
Scientific Knowledge Infrastructure	0.455	0.021	0.021	0.085	-0.096	-0.053	0.048	-0.010	-0.068	0.011	0.048	-0.034	0.043	0.064	-0.062	0.327	1.000	
Technical Support Infrastructure	-0.025	0.004	0.023	-0.258	-0.029	0.014	0.077	0.012	-0.049	0.029	-0.052	-0.062	0.021	0.054	-0.002	-0.043	0.011	1.000

Table 5.11: Correlation among the Second-order Exogenous Variables

	Firms' Cooperation	Firms' Financial Capability	Firms' Resource Capability	Firms' Transformational Actions	Funding Infrastructure	Government Support Infrastructure and Institution	Innovation Outcome	Knowledge Infrastructure	Market Knowledge Factor
Firms' Cooperation	1.000								
Firms' Financial Capability	0.000	1.000							
Firms' Resource Capability	-0.035	0.072	1.000						
Firms' Transformational Actions	-0.005	0.050	-0.004	1.000					
Funding Infrastructure	-0.011	0.017	0.068	0.011	1.000				
Government Support Infrastructure and Institution	0.035	0.062	0.075	-0.045	-0.016	1.000			
Innovation Outcomes	-0.039	0.003	0.499	-0.077	0.079	0.067	1.000		
Knowledge Infrastructure	-0.226	-0.001	0.017	-0.056	-0.048	0.035	0.055	1.000	
Market Knowledge Factor	-0.002	0.072	0.108	0.151	0.066	0.019	0.059	0.063	1.000

As it is shown in Table 5.12 and Table 5.13, the VIF of variables for the first-order (varies between 1.056 and 2.433) and the second-order (varies ranges from 1.012 to 1.068) models are below five (Hair *et al.*, 2011; Myers, 1990). In addition, tolerance values for the first-order (varies between 0.409 and 0.947) and the second-order models (ranges from 0.936 to 0.988) are above 0.2 (Hair *et al.*, 2011; Menard, 1995).

Table 5.12: VIF and Tolerance Values for First-order Exogenous Variables

	VIF	Tolerance
Business Knowledge Infrastructure	1.422	0.703
Demand Articulation	1.822	0.549
External Resource Capability	1.350	0.741
Financial Institution	1.113	0.898
Industry Knowledge Infrastructure	1.779	0.562
Information Asymmetries	2.323	0.430
Intellectual Property Protection	1.690	0.592
Inter-firm Cooperation	2.443	0.409
Internal Resource Capability	1.332	0.751
Organisational Directionality	1.470	0.680
Own Source of Fund	1.094	0.914
Private Funding Infrastructure	1.056	0.947
Public and Other Funding Infrastructure	1.057	0.946
Resource Directionality	1.627	0.615
Scientific Knowledge Cooperation	1.913	0.523
Scientific Knowledge Infrastructure	1.580	0.633
Technical Support Infrastructure	1.092	0.916

Table 5.13: VIF and Tolerance Values for Second-order Exogenous Variables

	VIF	Tolerance
Firms' Cooperation	1.059	0.945
Firms' Financial Capability	1.015	0.985
Firms' Resource Capability	1.027	0.974
Firms' Transformational Actions	1.033	0.968
Funding Infrastructure	1.012	0.988
Government Support Infrastructure and Institution	1.015	0.985
Knowledge Infrastructure	1.068	0.936
Market Knowledge Factor	1.049	0.953

Based on the findings provided in the tables above, there is no collinearity problem. Therefore, the predictor constructs are not biased. Once the collinearity issues are evaluated and cleared, the significance and relevance of the relationships as stipulated in the structural model are assessed to test the proposed hypotheses.

5.3.2. Significance and Relevance of Structural Model Relationships

This assessment is done using standardised path coefficients estimated by PLS algorithm. Subsequently, bootstrapping is run with 2000 replications to estimate the standard deviation of path coefficients, *t*-value and p-value for each path in their respective model. The first-and second-order structural models' path coefficients, their significance and the decision on whether a particular measure is a systemic enabler or a problem (based on the direction of the relationship) are presented in tables 5.14 and 5.15.

Table 5.14: First-order Structural Model Path Coefficient (β) Sizes and Significance

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Enablers / Barriers
Firm Related Factors						
External Resource Capability -> Innovation Outcomes	0.241 (2)	0.240	0.058	4.135	0.000	Enabler***
Internal Resource Capability -> Innovation Outcomes	0.331 (1)	0.333	0.050	6.573	0.000	Enabler***
Own Source of Fund -> Innovation Outcomes	0.017	-0.020	0.057	0.295	0.768	Enabler
Business Knowledge Infrastructure -> Innovation Outcomes	0.033	0.059	0.066	0.491	0.623	Enabler
Inter-firm Cooperation -> Innovation Outcomes	0.004	-0.004	0.070	0.052	0.959	Enabler
Scientific Knowledge Cooperation -> Innovation Outcomes	0.001	0.002	0.069	0.012	0.991	Enabler
Demand Articulation -> Innovation Outcomes	-0.057	-0.049	0.055	1.033	0.302	Barrier
Organizational Directionality -> Innovation Outcomes	0.078	0.067	0.063	1.233	0.218	Enabler
Resource Directionality -> Innovation Outcomes	-0.068	-0.056	0.055	1.237	0.216	Barrier
Contextual Factors (National)						
Financial Institution -> Innovation Outcomes	0.041	0.041	0.038	1.095	0.274	Enabler
Technical Support Infrastructure -> Innovation Outcomes	0.077	0.048	0.070	1.099	0.272	Enabler
Industry Knowledge Infrastructure -> Innovation Outcomes	-0.051	-0.034	0.086	0.596	0.551	Barrier
Scientific Knowledge Infrastructure -> Innovation Outcomes	0.006	-0.020	0.066	0.097	0.923	Enabler
Public and Other Funding Infrastructure -> Innovation Outcomes	-0.017	0.004	0.046	0.373	0.709	Barrier
Private Funding Infrastructure -> Innovation Outcomes	0.051	0.049	0.037	1.388	0.165	Enabler
Information Asymmetries -> Innovation Outcomes	-0.028	-0.027	0.062	0.461	0.645	Barrier
Intellectual Property Protection -> Innovation Outcomes	0.008	0.012	0.043	0.191	0.849	Enabler

Note: * indicates significance at 90%, ** 95% and *** 99%

Table 5.15: Second-order Structural Model Path Coefficient (β) Sizes and Significance

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Enabler / Barrier
Firm Related Factors						
Firms' Cooperation -> Innovation Outcomes	-0.014	-0.011	0.041	0.338	0.736	Barrier
Firms' Financial Capability -> Innovation Outcomes	-0.033	-0.033	0.037	0.894	0.371	Barrier
Firms' Resource Capability -> Innovation Outcomes	0.493	0.497	0.031	16.010	0.000	Enabler***
Firms' Transformational Actions -> Innovation Outcomes	-0.072	-0.013	0.095	0.761	0.447	Barrier
Contextual Factors (National)						
Funding Infrastructure -> Innovation Outcomes	0.048	0.040	0.056	0.856	0.392	Enabler
Government Support Infrastructure and Institution -> Innovation Outcomes	0.029	0.039	0.045	0.647	0.518	Enabler
Knowledge Infrastructure -> Innovation Outcomes	0.040	0.032	0.059	0.669	0.504	Enabler
Market Knowledge Factor -> Innovation Outcomes	0.013	0.014	0.038	0.339	0.734	Enabler

Note: * indicates significance at 90%, ** 95% and *** 99%

Out of the seventeen first-order measures, twelve of them had positive path coefficient indicating that they were enablers of innovation outcomes. Five of them returned with negative path coefficients indicting their hampering effect on innovation outcomes. Two of the enablers (namely internal resource capability, external resource capability) had a significant positive relationship with Innovation outcomes. None of the barriers indicated a significant relationship with innovation outcomes. Among the significant enablers, internal resource capability is the strongest enabler based on the value of path coefficient followed by external resource capability of firms. The strongest barrier is the resource directionality followed by demand articulation. These results show evidence of only two enablers to innovation outcomes in the NIS at the micro level.

Considering the nine firm related factors, internal resource capability, and external resource capability showed a significant positive relationship with innovation outcomes, while the rest did not show any significant relationship. Considering the contextual factors, none of them showed any significant relationship. Considering the second-order factors, only one significant enabler (resource capability) emerged for the services sector.

5.3.3. Explanatory Power of the Model

The PLS path modelling estimation using first-order measures for the services sector is shown in figure 5.4. Based on the diagram, the coefficient of determination, R^2, is 0.278 for the Innovation Outcomes (IO) endogenous latent variable, which means that the seventeen first-order latent variables explain 27.8% of the variance in IO.

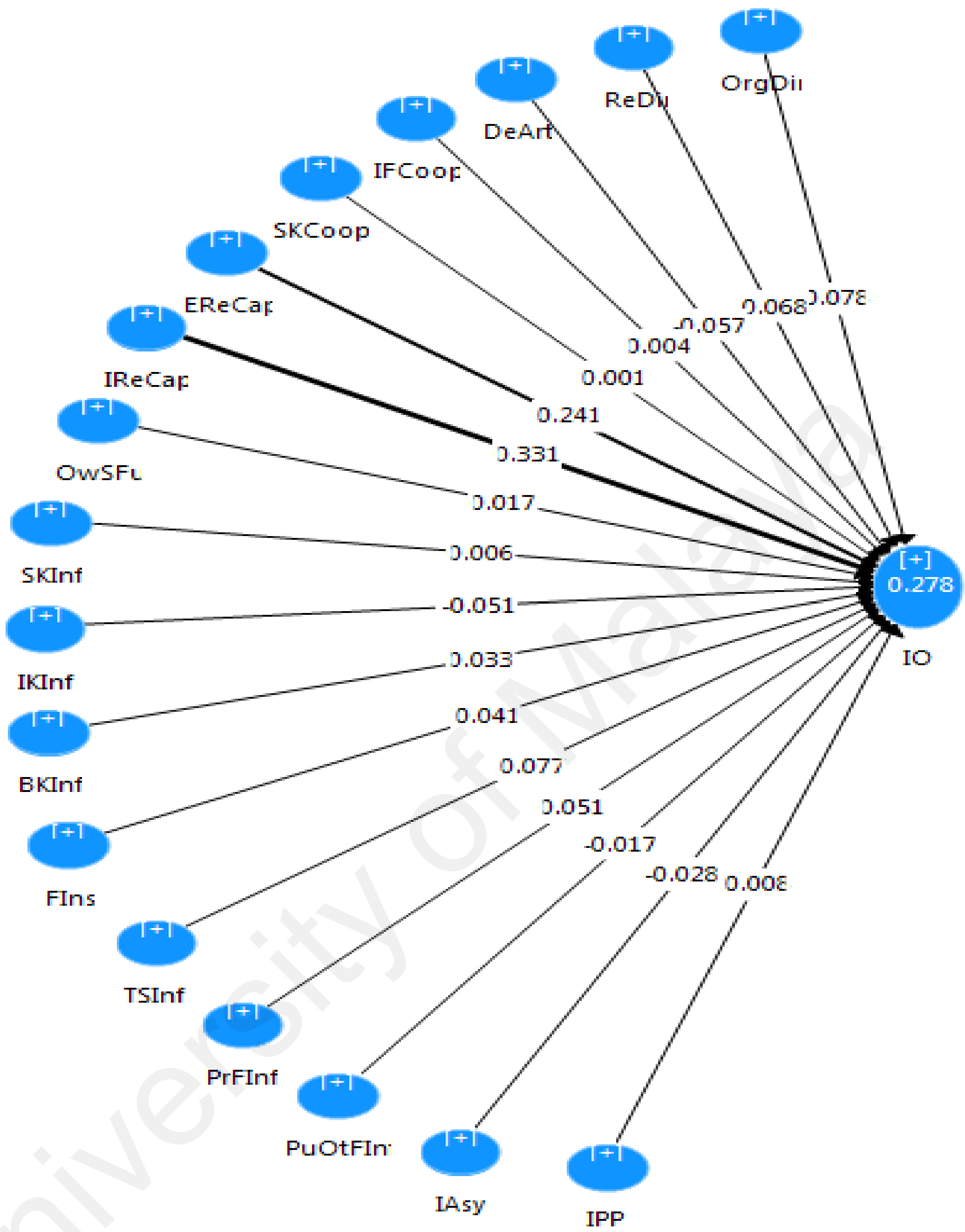

Figure 5.4: PLS First-order Structural Model for Services Sector

Legend: OrgDir – Organisational Directionality; ReDir – Resource Directionality; DeArt – Demand Articulation; IFCoop – Interfirm Cooperation; SKCoop – Scientific Knowledge Cooperation; EReCap – External Resource Capability; IReCap – Internal Resource Capability; OwSFu – Own Source of Funding; SKInf – Scientific Knowledge Infrastructure; IKInf – Industry Knowledge Infrastructure; BKInf – Business Knowledge Infrastructure; Fins – Financial Institution; TSInf – Technical Support Infrastructure; PrFInf – Private Funding Infrastructure; PuOtFInf – Public and Other Funding Infrastructure; IAsy – Information Asymmetries; IPP – Intellectual Property Protection

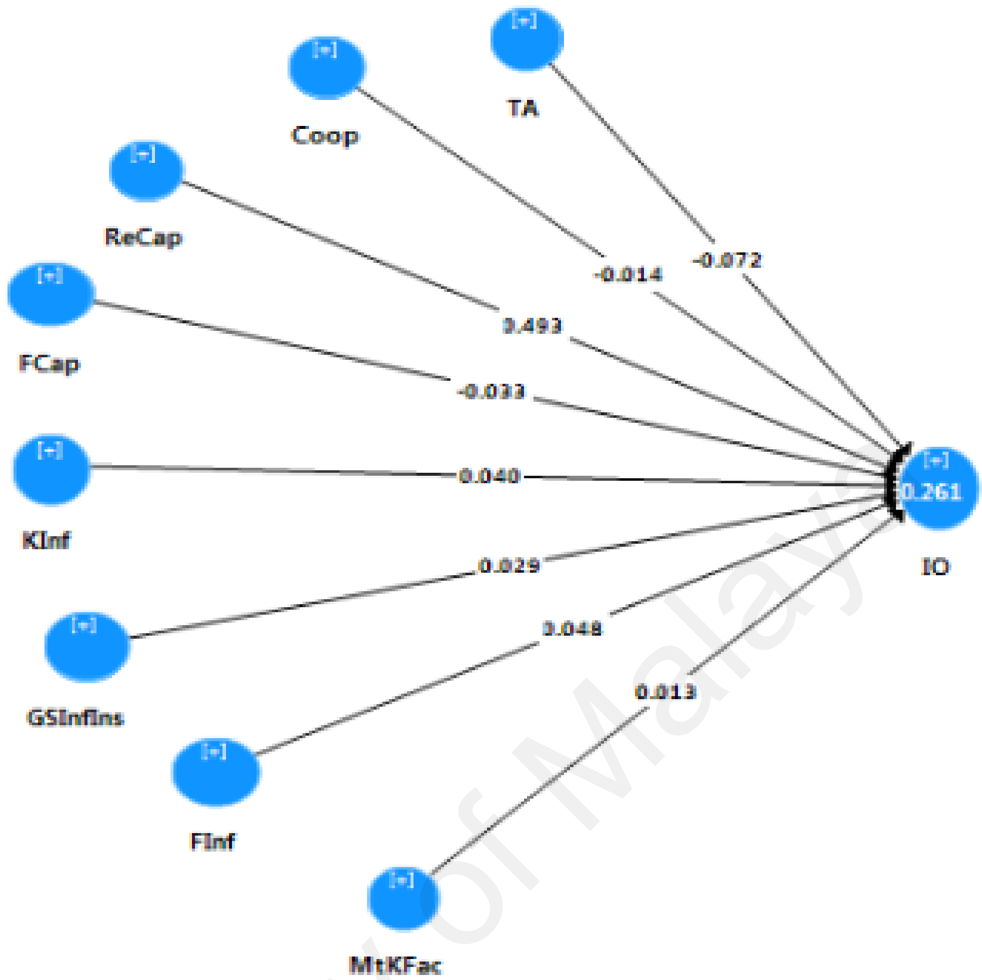

Figure 5.5: PLS Second-order Structural Model for Services Sector

Legend: TA –Transformational Actions; Coop –Cooperation; ReCap – Resource Capability; FCap – Financial Capability; KInf – Knowledge Infrastructure; GSInfIns – Government Support Infrastructure and Institution; Finf – Funding Infrastructure; MtKFac – Market Knowledge Factor.

The PLS path modelling estimation using second-order measures for the services sector is shown in figure 5.5. Based on the diagram, the coefficient of determination, R^2, is 0.261 for the Innovation Outcomes (IO) endogenous latent variable, which means that the eight second-order latent variables explain 26.1% of the variance in IO.

The R^2 value satisfied the minimum requirement of the 10% cut off value and significant with substantial explanatory power indicating the predictive accuracy of the model for planning purposes. Above all, the variability explained by the endogenous constructs provided the model with a substantial nomological validity in the services sector of an emerging economy context of Malaysia, whereby large numbers of indifferent factors influence the ultimate dependent variable 'innovation outcomes'. However, the models (both first-order and second-order) specified here had adequate merit as they explained about 27.8% and 26.1% respectively of the variance in the innovation outcomes of firms.

5.3.4. Assessment of Effect Size

According to Wong (2013), effect sizes as indicated as f^2 can be estimated to assess how much a predicting (exogenous) variable contributes to an endogenous latent variable's R^2 value by SmartPLS 3 bootstrapping procedure. The author also provided a rule of thumb indicating that f^2 value of 0.02 shows a small effect, f^2 value of 0.15 shows a medium effect, and f^2 value of 0.35 shows a large effect. The f^2 values estimated are presented below in Tables 5.16 and 5.17 for first- and second-order measures respectively.

Table 5.16: Effect Size for First-order Measures

	f square	**Size of the effect**
Business Knowledge Infrastructure -> Innovation Outcomes	0.001	Small
Demand Articulation -> Innovation Outcomes	0.002	Small
External Resource Capability -> Innovation Outcomes	0.059	Small
Financial Institution -> Innovation Outcomes	0.002	Small
Industry Knowledge Infrastructure -> Innovation Outcomes	0.002	Small
Information Asymmetries -> Innovation Outcomes	0.000	Negligible
Intellectual Property Protection -> Innovation Outcomes	0.000	Negligible
Inter-firm Cooperation -> Innovation Outcomes	0.000	Negligible
Internal Resource Capability -> Innovation Outcomes	0.114	Small
Organisational Directionality -> Innovation Outcomes	0.006	Small
Own Source of Fund -> Innovation Outcomes	0.000	Negligible
Private Funding Infrastructure -> Innovation Outcomes	0.003	Small
Public and Other Funding Infrastructure -> Innovation Outcomes	0.000	Negligible
Resource Directionality -> Innovation Outcomes	0.004	Small
Scientific Knowledge Cooperation -> Innovation Outcomes	0.000	Negligible
Scientific Knowledge Infrastructure -> Innovation Outcomes	0.000	Negligible
Technical Support Infrastructure -> Innovation Outcomes	0.008	Small

Table 5.17: Effect Size for Second-order Measures

	f square	Size of the Effect
Firms' Cooperation	0.000	Negligible
Firms' Financial Capability	0.001	small
Firms' Resource Capability	0.321	medium
Firms' Transformational Actions	0.007	small
Funding Infrastructure	0.003	small
Government Support Infrastructure and Institution	0.001	small
Knowledge Infrastructure	0.002	small
Market Knowledge Factor	0.000	negligible

From the tables, it is evident that mostly the effect sizes are negligible or small in both the sectors. However, 'firms' resource capability' has a medium effect on 'innovation outcomes'. However, most of the predicting variables have contributed to the endogenous variable 'innovation outcomes'.

5.3.5. Assessment of Predictive Relevance

Predictive relevance indicates how accurately the model can predict innovation outcomes as an endogenous construct in the model. This research used the cross-validated redundancy approach to compute Stone-Geisser's Q^2 effect size as suggested by Chin (2010). A Q^2 greater than zero implies that the model has predictive relevance, whereas a Q^2 less than zero suggests that the model lacks predictive relevance (Chin, 1988). Blindfolding procedure in SmartPLS is used to estimate the Q^2 values and are presented in Table 5.18.

Table 5.18: Predictive Relevance for the Endogenous Dimension – Services Sector

	Q2
First-order measures of Innovation Outcomes	0.010
Second-order measures of Innovation Outcomes	0.013

Since the Q^2 values of innovation outcomes for both first- and second-order measures are more than zero, both models have predictive relevance.

5.4. Comparison between Manufacturing and Services Sectors

The first and second order systemic enablers and problems of the NIS representing micro and macro level issues are presented in tables 5.19 and 5.20.

Table 5.19: Comparison of Systemic Enablers and Problems at the Micro Levels

	Enablers		Barriers/ Problems	
	Manufacturing	**Services**	**Manufacturing**	**Services**
First-order Firm-Related Factors				
	Internal Resource Capability ***	External Resource Capability ***	Financial Capability (Own Source of Fund)	Demand Articulation
	External Resource Capability ***	Internal Resource Capability ***	Cooperation	Resource Directionality
	Notion of Cooperation ***	Own Source of Fund	Demand Articulation ***	
	Organisational Directionality	Inter-firm Cooperation	Resource Directionality	
		Scientific Knowledge Cooperation		
		Organizational Directionality		
First-order Contextual Factors				
	Government Technical Support Infrastructure **	Financial Institution	Private Source of Fund **	Industry Knowledge Infrastructure
	Public Institution ***	Technical Support Infrastructure	Public Funding Infrastructure *	Public and Other Funding Infrastructure
		Business Knowledge Infrastructure	Information Asymmetries	Information Asymmetries
	Knowledge Infrastructure (Strategic Info) **	Scientific Knowledge Infrastructure		
	Intellectual Property Protection **	Private Funding Infrastructure		
		Intellectual Property Protection		

Note: * indicates significance at 90%, ** 95% and *** 99%

Table 5.20: Comparison of Systemic Enablers and Problems at the Macro Levels

	Enablers		Barriers/ Problems	
	Manufacturing	**Services**	**Manufacturing**	**Services**
Second-order Firm-Related Factors	Capability and Cooperation*** Transformational Actions **	Resource Capability ***		Cooperation Financial Capability Transformational Actions
Second-order Contextual Factors	Government Support Infrastructure and Institution *** Infrastructure and Institution for Private Sources ***	Funding Infrastructure Government Support Infrastructure and Institution Knowledge Infrastructure Market Knowledge Factor	Funding Infrastructure Market Knowledge Factor **	

Note: * indicates significance at 90%, ** 95% and *** 99%

While there are ten significant relationships in first-order and five in the second-order in the manufacturing sector, services sector shows only two in first-order and one in second-order. The significant ones of services sector are aligned with the manufacturing sector. The first-order dimensions that are significant enablers of innovation outcomes in both the sectors are 'internal resource capability' and 'external resource capability'. However, the direction of relationships of the first-order dimensions of firm attributes (irrespective of their significance) are scrutinised, both the sectors are in alignment except for 'financial capability' and 'cooperation'. These two established a negative relationship (systemic problem) with innovation outcomes for the manufacturing sector, while they are in a positive relationship in the services sector. When the relationship of first-order contextual factors with innovation outcomes is checked, only 'private funding infrastructure' differs. While this an enabler for the services sector, it is a problem for the manufacturing sector. At the macro view (second-order dimensions), the 'capability' dimension that includes cooperation has become an enabler for the manufacturing sector, but 'cooperation' and 'financial capability' have turned out to be systemic problems for the services sector. The same goes for the dimension 'transformational actions'. These findings indicate that there are similarities and differences between the sectors.

5.5. Research Findings

The summary and discussion of the results of hypothesis 2 are presented below. Hypothesis 2 attempts to answer the second research issue as presented above by investigating systemic problems and enablers through the direct relationship of the dimensions of NIS with innovation outcomes. A summary and discussion of the findings are presented below.

5.5.1. Summary of Findings

Research question 2, the associated main hypothesis and sub-hypotheses are presented in table 5.21 with the results and a general remark on contribution to theory.

Table 5.21: Summary of Findings for Research Question 2

Research Questions		Research Hypotheses		Conclusion	Contribution
RQ 2.0:	**What are the enablers and barriers to innovation for firms in NIS of an emerging economy? How do they differ between manufacturing and services sectors?**	**H2.0:**	**The dimensions (both first and second order) of NIS regarding firm attributes and their contexts have a significant effect on innovation outcomes.**	**The findings show significant enablers and problems of NIS both at the micro and macro levels in facilitating innovation outcomes regarding firm attributes and their contexts. The findings also differ between manufacturing and services sectors.** **Therefore, $H_{2.0}$ is supported.**	**A significant contribution to theory and practice**
rq 2.1:	What are the enablers and barriers to innovation for firms in manufacturing sector within NIS?	$H_{2.1}$:	The dimensions (both first and second order) of NIS regarding firm attributes and their contexts have a significant effect on innovation outcomes in the manufacturing sector.	There are seven dimensions with the significant positive relationship and three with the significant negative relationship at the micro view. These findings indicate evidence of seven systemic enablers (internal resource capability, external resource capability, notion of cooperation, government technical support infrastructure, public institution, knowledge infrastructure and intellectual property protection). Also, there exist three systemic problems (demand articulation, private source of fund and public funding infrastructure) in the NIS of manufacturing sector at the micro view in the research context. There are four dimensions with the significant positive relationship and one with a significant negative relationship with innovation outcomes at the macro view. These findings indicate evidence for four systemic enablers (capability, transformational actions, Government support infrastructure and institution and infrastructure and institution for private sources) and one systemic problem (market knowledge factor) in the NIS of manufacturing sector at the macro view in the research context. Therefore, $H_{2.1}$ is partly supported.	

	Research Questions		Research Hypotheses	Conclusion	Contribution
	'Table 5.21, continued'.'				
rq 2.2:	What are the enablers and barriers to innovation for firms in services sector within NIS?	$H_{2.2}$:	The dimensions of NIS (both first and second order) regarding firm attributes and their contexts have a significant effect on innovation outcomes in the services sector.	There are two dimensions with the significant positive relationship and none with the significant negative relationship at the micro view. These findings indicate evidence of only two systemic enablers (internal resource capability, external resource capability) and no systemic problems in the NIS of services sector at the micro view in the research context. There is only one dimension with the significant positive relationship and none with a significant negative relationship with innovation outcomes at the macro view. These findings indicate evidence of one systemic enabler (capability), and no systemic problems in the NIS of manufacturing sector at the macro view in the research context. Therefore, $H_{2.2}$ is partly supported.	
rq 2.3:	How do the enablers and barriers to innovation differ between manufacturing and services sector?	$H_{2.3}$:	There is a difference between manufacturing and services sectors in the direct influence of firm attributes and their contexts on innovation outcomes in NIS.	There are differences between manufacturing and services sectors regarding the directions of the relationship in the micro dimensions 'financial capability' and 'cooperation 'and 'private funding infrastructure'. These are systemic problems for the manufacturing sector, but enablers for the service sector. However, at the macro-view 'transformational actions' and 'capability' that includes cooperation aspect have become enablers for the manufacturing sector. 'Cooperation' and 'financial capability' have turned out to be systemic problems for the services sector. Therefore, $H_{2.3}$ is also partly supported.	

5.5.2. Discussion of Findings

This section discusses the results of the investigation of research issue 2 through hypothesis 2, which is on systemic problems and enablers in National Innovation System (NIS) of Malaysia. Edquist (2002) indicated that by empirically analysing the innovation system framework, specific problems that should be objects of innovation policy could be identified. Therefore, this study investigated enablers and problems in the systemic constituents of the NIS regarding firm attributes and their contexts derived through research issue 1. Based on Tien (2007), who highlighted differences between goods (manufacturing) and services sector, this study also investigates the differences between sectors regarding innovation enablers and barriers. This objective is achieved by exploring the direction of the effect of dimensions of NIS on innovation outcomes. The summary of the findings is presented in table 5.21. The sub-research issues are discussed below.

5.5.2.1. Research Issue 2.1

'What are the enablers and barriers to innovation for firms in manufacturing sector within NIS?'

The investigation shows evidence of seven systemic enablers (internal resource capability, external resource capability, notion of cooperation, government technical support infrastructure, public institution, knowledge infrastructure and intellectual property protection) and three systemic problems (demand articulation, private source of fund and public funding infrastructure) in the NIS of manufacturing sector at the micro level of the research context. The results show that firms' lack of ability to articulate the demand and lack of funding from both public and private sector emerge as barriers to innovation outcomes in the manufacturing sector at the micro level.

The findings also show evidence for four systemic enablers (capability, transformational actions, Government support infrastructure and institution and infrastructure and institution for private sources) and one systemic problem (market knowledge factor) in the NIS of manufacturing sector at the macro view in the research context. Firms' perceive their capability regarding internal resources and ability to make use of external resources and their cooperation with different parties, their transformative actions regarding planning and directing resources and finance, and public and private institutions and infrastructure enable innovation outcomes from the macro view. However, the market regarding 'information asymmetries' act as a barrier to innovation outcomes. This finding indicates that firms are not able to take advantage of the information asymmetries in the market for innovation in the manufacturing sector.

In general, in the manufacturing sector, from the micro-view, firms are challenged regarding articulating demand for innovation and allocating funds or getting funding for innovation-related projects. When firm's perspectives are brought to a slightly higher level, it can be noted that they are not able to take advantage of the asymmetries of the market knowledge for innovation. The firms perceive that they are able in their level and supported by the context regarding infrastructure and institution from both public and private entities. Firms from manufacturing sector view infrastructure and institution as a support aspect without clearly distinguishing them. The manufacturing firms' perception of their ability can be explained as the majority of the sample employed for this study belong to large sized firms (42% representing firms with a sales turnover of more than RM 25 million or full-time employees of more than 150). Medium-sized firms (33%) with sales turnover between RM 10 million and RM 25 million (or full-time employees of 51 to 150) follow this. This common nature of the firms in the manufacturing sector is that they require help regarding articulating demand, funding infrastructure and market details to perform well to realise innovation.

The findings of systemic enabler and problems for manufacturing sector are quite aligned with Chaminade et al. (2012). The authors highlighted that the NIS could have problems in institutional aspects, science and technology (S&T) infrastructure, network and support services. These dimensions are aligned with 'capability' that includes collaboration (network), 'government support infrastructure and institution' (institution and support services), 'institution and infrastructure for private sources' (science and technology infrastructure) dimensions of the manufacturing sector. These dimensions in the manufacturing sector of this study establish a significant relationship with innovation outcomes. Chaminade et al. (2012) did not establish the relationship of these dimensions with innovation outcomes. 'Transformative actions' is an additional dimension established by this study compared to Chaminade et al. (2012), but it is in line with the conceptual discussions of Weber and Rohracher (2012) and the qualitative study of Lamprinopoulou, Renwick, Klerkx, Hermans, and Roep (2014).

5.5.2.2. Research Issue 2.2
What are the enablers and barriers to innovation for firms in services sector within NIS?

The findings show evidence of only two systemic enablers (internal resource capability, external resource capability) and no systemic problems in the NIS of services sector at the micro view in the research context. These findings indicate that the firms in services sector believe that their capability regarding their resources and their ability to make use of external resources enable innovation outcomes. They do not perceive problems that affect innovation outcomes negatively. The findings also indicate evidence of one systemic enabler (resource capability), and no systemic problems in the NIS of service sector at the macro view in the research context, which indicate that only the people and technology that the firms possess in services sector enable innovation.

In the services sector, the firms do not perceive any challenges in achieving innovation outcomes in the micro-level, which can be explained as most of the firms from services sector in this sample are from small (46%) to medium (37%) sized firms. The small firms are with sales turnover between RM 200000 and less than RM 1 million or full-time employees of 5 to 19, and the medium-sized firms are with sales turnover between RM 1 million and RM 5 million or full-time employees of 20 to 50. Innovation outcomes may not be the organisational priority or direction and emphasise in their actual practice. It is important to note that most of the dimensions (both at the micro and macro level) for services sector and some of them from manufacturing sector did not establish significant relationships with innovation outcomes. There may be different possible reasons that can be attributed to this. In general, the analysis picked up more enablers than barriers in both the sectors, which seems to be promising. However, it is possible for the few problems picked up overpowering all the enablers firms perceive, which needs further investigation.

5.5.2.3. Research Issue 2.3
How do the enablers and barriers to innovation differ between manufacturing and services sector?

The main difference is that there are only a few (three at the micro-level and one at the macro level) significant relationships in services sector compared to manufacturing sector (ten at the micro-level and five at the macro-level). The micro dimensions ‘ source of fund', 'cooperation 'and 'private funding infrastructure' are systemic problems for the manufacturing sector, but enablers for the services sector. These findings indicate that own source of funding for firms in the manufacturing sector, their cooperation initiatives and private funding available to them do not enable them to produce innovation outcomes. However, firms in services sector perceive all these dimensions at the firm level favourable towards innovation outcomes. While this makes sense with the manufacturing sector, it is difficult to explain the situation in the services sector, and it requires further investigation.

At the macro-view, 'transformational actions' and 'capability' that includes cooperation aspect have become enablers for the manufacturing sector. 'Transformational actions', 'cooperation' and 'financial capability' have turned out to be systemic problems for the services sector. When the firms' views are taken to the higher level (macro-level), it can be noted that firms' visions and plans, their cooperation activities with universities, other firms, industries and so on, and their financial capability are not favourable towards innovation outcomes. However, manufacturing sector's directions and capability are in a position to enable innovation outcomes.

The findings confirm Lundvall (2005), who insisted that firms belonging to different sectors contribute differently to innovation processes and differ in how they innovate, interact with other firms, interact with the knowledge infrastructure and draw upon markets for labour, finance and intellectual property. In line with Lundvall (2005), Arundel, Lorenz, Lundvall, and Valeyre (2007) and Tien (2007) also suggested dividing the economy into two sectors. The findings also confirm OECD (2013) report's certain reasons to fear that Malaysia may be caught in a 'middle-income trap' due to relatively slowly evolving Research and Development (R&D) and innovative capacity over a more extended period and lack of private investment in the domestic economy. The slowly evolving R&D capability is mainly due to funding support.

5.6. Summary

This chapter seeks to investigate systemic problems and enablers in National Innovation System (NIS) regarding firm attributes and their contexts, which can be comprehensively managed to enhance innovation outcomes. The results from manufacturing sector show evidence of seven systemic enablers and three systemic problems in the NIS of Malaysia at the micro level out of the fifteen first-order factors. Seven of the enablers (namely internal resource capability, external resource capability, notion of cooperation, government technical support infrastructure, public institution, knowledge infrastructure and intellectual property protection) had a significant positive relationship with Innovation outcomes. Only three (demand articulation, private source of fund and public funding infrastructure) of them showed a significant negative relationship with Innovation outcomes. Among the significant enablers, 'public institution' is the strongest enabler based on the value of path coefficient followed by internal resource capability of firms and their notion of alignment. The biggest problem is the 'demand articulation' followed by 'private source of fund' and 'public funding infrastructure'. The results showed evidence of four enablers ('capability', 'transformational actions', 'Government support infrastructure and institution' and 'infrastructure and institution for private sources') and one barrier ('market knowledge factor') at the macro level. Firms' 'capability' emerged as the strongest enabler followed by 'government support infrastructure and institution'.

The results from services sector show evidence of only two enablers ('internal resource capability' and 'external resource capability') of innovation outcomes in the NIS of Malaysia at the micro level. None of the barriers indicated a significant relationship with innovation outcomes. Among the significant enablers, internal resource capability is the strongest enabler based on the value of path coefficient followed by external resource capability of firms. The strongest barrier is the resource directionality followed by demand articulation. These results show evidence of only two enablers of innovation outcomes in the NIS at the micro level. The findings also indicate that there is only one significant enabler (capability) at the macro level. A very few (only two first-order and one second-order) dimensions established a significant relationship with innovation outcomes in the services sector. There are also differences in the direction of the relationship of the dimensions of NIS with innovation outcomes between the sectors.

The findings of the study provide evidence for enabling and problematic dimensions of NIS in the research context, which is an important contribution of the study. As Kubeczko and Weber (2009) indicate, understanding of systemic enablers and problems is critical for proactively stimulating and thus prioritising specific innovation activities to exploit opportunities that could contribute to moving in the direction of desired long-term transformative change.

CHAPTER 6: A STRUCTURAL ANALYSIS OF THE RELATIONSHIPS BETWEEN DIMENSIONS OF NATIONAL INNOVATION SYSTEM AND INNOVATION OUTCOMES

6.1 Introduction

This chapter presents the findings of the third research objective. The objective is to examine the indirect relationships of the measures of NIS regarding national contexts on innovation outcomes through firm attributes empirically, which can be comprehensively governed at the national level to enhance innovation outcomes. The hypothesis associated with this objective is:

H_3 : The effect of NIS contextual factors on innovation outcomes is intervened or moderated by firm attributes

As discussed in the literature, firms are heterogeneous, and they differ based on sectors. Therefore, hypothesis 2 is tested in sub-hypotheses presented below:

$H_{3.1}$: The effect of NIS contextual factors on innovation outcomes is intervened by firm attributes in the manufacturing sector.

$H_{3.2}$ The effect of NIS contextual factors on innovation outcomes is intervened by firm attributes in the services sector.

$H_{3.3}$ There is a difference between manufacturing and services sectors in the effect of NIS contextual factors on innovation outcomes intervened by firm attributes.

The direct and indirect effect of NIS contextual factors on innovation outcomes is examined using Structural Equation Modelling. Structural Equation Modelling (SEM) with Partial Least Square (PLS) approach is used as indicated in the methodology section. Analyses are performed using the SmartPLS 3.0 software. This section presents the outcome of the analysis. The outline of this section includes assessment of collinearity issue, significance and relevance of structural model relationships (with and without intervention), the explanatory power of the model, assessment of effect size and assessment of predictive relevance for manufacturing and services sectors. The chapter concludes with a comparison between the sectors and summary of the findings.

6.2. Structural (Inner Model) Analysis for Manufacturing Sector

The assessment of structural (inner) model requires reliable and valid measurement (outer) model estimates as per Henseler et al. (2009). The reliability and validity of the measurement model estimates are established and summarised in chapter 4. The structural analysis of the proposed model for manufacturing sector was done based on the five steps structural model assessment advocated by Hair et al. (2013) as indicated below in figure 6.1.

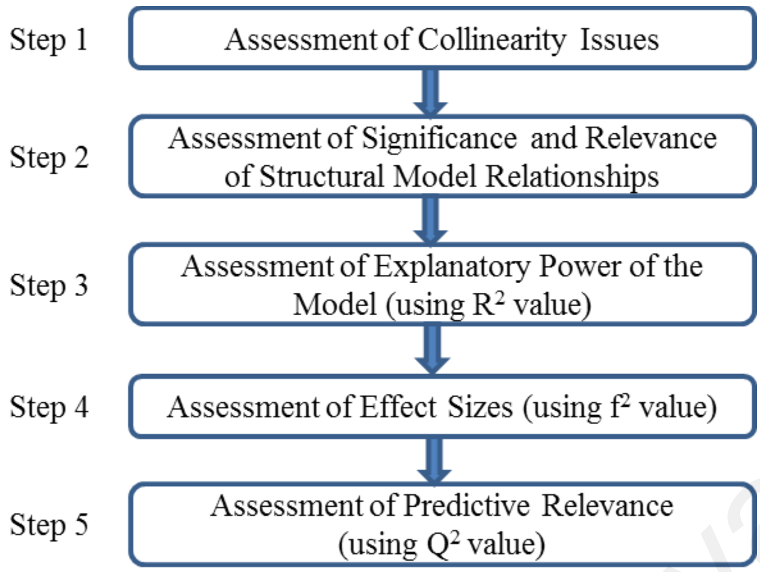

Figure 6.1: PLS-SEM Structural Model Assessment

(Hair et al., 2013, p. 169)

6.2.1. Assessment of Collinearity Issues

This research examined the collinearity issue using the correlation among exogenous variables, their VIF, and tolerance. First of all, correlations among 'market knowledge factor', 'funding infrastructure', 'government support infrastructure and institution', and 'infrastructure and institutions for private sources' as exogenous variables and 'firms' capability and cooperation' and 'firms' transformative actions' as the mediator or intervening variables were observed to evaluate the collinearity issue. Their VIF and tolerance are also estimated. The analysis is done by using SmartPLS, and latent variable scores for each construct was computed. These values are used for collinearity assessment among variables. Correlation matrix for exogenous variables and the intervening variables are shown in Table 6.1.

Table 6.1: Correlation among the Exogenous and Intervening Variables

	Firms' Capability and Cooperation	Firms' Transformational Actions	Information Asymmetries	Infrastructure and Institution for Private Sources	Infrastructure and Institution for Public Sources	Other and Public Sources of Funding
Firms' Capability and Cooperation	1.000					
Firms' Transformational Actions	0.255	1.000				
Information Asymmetries	0.115	0.708	1.000			
Infrastructure and Institution for Private Sources	0.666	0.305	0.124	1.000		
Infrastructure and Institution for Public Sources	0.406	0.163	-0.003	0.301	1.000	
Other and Public Sources of Funding	0.116	0.068	0.115	0.174	0.316	1.000

Correlation coefficients range from -0.003 to 0.708 and are below 0.8 indicating that there is no high correlation among variables as per Field (2013).

Table 6.2: VIF and Tolerance Values for Exogenous and Mediating Variables

Mediating and Exogenous Variables	Firms' Capability & Cooperation' as dependent variable		Firms' Transformational Actions' as dependent variable		Innovation Outcomes as dependent variable	
	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance
Firms' Capability					1.818	0.550
Firms' Transformational Actions					2.397	0.417
Information Asymmetries	1.025	0.976	1.025	0.976	2.124	0.471
Infrastructure and Institution for Private Sources	1.130	0.885	1.130	0.885	1.738	0.575
Infrastructure and Institution for Public Sources	1.214	0.824	1.214	0.824	1.386	0.721
Other and Public Sources of Funding	1.128	0.886	1.128	0.886	1.161	0.862

The VIF of variables vary between 1.025 and 2.397 and are below five (Hair *et al.*, 2011; Myers, 1990). Also, tolerance values vary between 0.417 and 0.976 and are above 0.2

(Hair *et al.*, 2011; Menard, 1995). Since there is no collinearity problem; the predictor constructs are not biased.

6.2.2. Significance and Relevance of Structural Model Relationships

Once the collinearity issues are evaluated and cleared, the significance and relevance of the relationships as stipulated in the structural model are assessed to test the proposed hypotheses. This assessment is done using standardised path coefficients estimated by PLS algorithm. Subsequently, bootstrapping is run with 2000 replications to estimate the standard deviation of path coefficients, *t*-value and p-value for each path in their respective model. The effect of NIS contextual factors on innovation outcomes with and without intervention are presented below.

6.2.2.1. Effect without Intervening Variables

The third objective discussed here aims to test the intervening effect or indirect effect of the national contextual factors on the innovation outcomes through frim attributes. The first step is examining the total effect. Total effect represents the path coefficient (c) before introducing the mediating or intervening variables into the model. Therefore, a model is developed by regressing from exogenous variables ('government support infrastructure and institution', 'infrastructure and institution for private sources', 'public funding infrastructure' and 'market knowledge factor') on innovation outcomes without the intervening variables ('firms' capability and cooperation' and 'firms' transformative actions'). The model without the intervening variables for the manufacturing sector is shown in figure 6.2.

Standardised path coefficients (β), their respective standard deviation, *t*-value and *p*-value estimated by running PLS method and bootstrapping with 2000 replications, are reported in Table 6.3. Mediation analysis is carried out with some modifications to the guidelines proposed for mediation analysis in PLS-SEM by Hair et al. (2014). Based on the guidelines, the significance of the path without the intervening variables (total effect, c) needs to be evaluated first. If the paths are significant, the intervening variables are introduced to the model and bootstrapping is done to analyse the mediation or intervention. If the indirect effect is significant, the variance accounted for (VAF) was calculated. A VAF value of greater than 80% is full mediation, a value between 20% and 80% is partial mediation and a value less than 20% means there is no mediation (Hair et al., 2014). The analysis started with the guidelines proposed by Hair et al. (2014) and the adaptations made are discussed below.

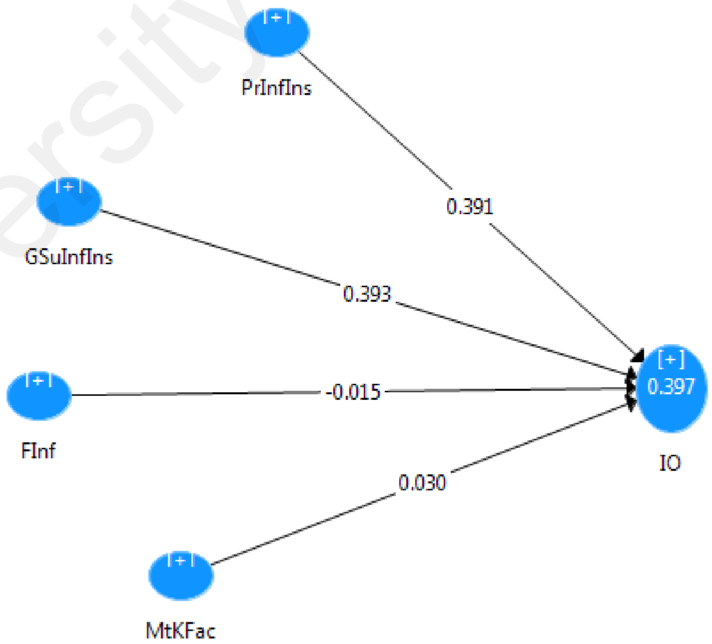

Figure 6.2: Model without the Intervening Variables

Legend: PrInfIns – Private Infrastructure and Institution; GSuInfIns – Government Support Infrastructure and Institution; Finf – Funding Infrastructure; MtKFac – Market Knowledge Factor; IO – Innovation Outcomes.

Table 6.3: Effect without the Intervening Variables (Total Effect, c)

Exogenous Variables to Innovation Outcomes (R^2 = 39.7%; Q^2 = 10.0%)	Standardised Path Coefficient (β)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Market Knowledge Factor -> Innovation Outcomes	0.029^{ns}	0.058	0.509	0.611
Infrastructure and Institution for Private Sources -> Innovation Outcomes	0.393^{***}	0.099	3.966	0.000
Government Support Infrastructure and Institution -> Innovation Outcomes	0.394^{***}	0.087	4.542	0.000
Other and Public Sources of Funding -> Innovation Outcomes	-0.021^{ns}	0.065	0.322	0.747

*, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels respectively. *ns* indicates not significant at 95% confidence level.

Figure 6.2 and table 6.3 illustrated that two out of the four relationships between exogenous and dependent variable are significant. The coefficient of determination, R^2, is 0.397 for the Innovation Outcomes (IO) endogenous latent variable, which means that the four exogenous variables considered here moderately explain 39.7% of the variance in IO. The findings showed that R^2 score of endogenous construct's (innovation outcomes) value satisfied the minimum requirement for the 0.10 cut off value, which had been the indication of a relatively parsimonious model as per Hanlon (2001) and Mustamil (2010). Also, the measure of predictive relevance is 10%. A Q^2 greater than '0' implies that the model has predictive relevance, whereas a Q^2 less than '0' suggests that the model lacks predictive relevance. While 'government support infrastructure and institution' and 'infrastructure and institution for private sources' are significantly associated with the endogenous variable 'innovation outcomes', 'market knowledge factor' and 'public funding infrastructure' are not.

Based on Hair et al. (2014), if the total effect is not significant without the mediating variables, there is no mediation. Therefore, the question arises here is whether to consider the insignificant independent variables further for mediation or not. Due to lack of conceptual and empirical understanding in this area, this study assumed that there could be intervention in the relationship between national contextual factors and innovation outcomes even if the total effect (c) is not significant. Based on the discussions of Hayes (2009), MacKinnon, Krull, and Lockwood, (2000), Mackinnon et al. (2004), Preacher and Selig (2012) and many other authors, there is reasonably broad consensus among statisticians that the total effect (*c*) (which is used in causal step approach) should not be used as a qualifying criteria for tests of mediation for a few reasons. The reasons are (a) causal step approach tests mediation without even estimating indirect effect, (b) mediation could be happening in a given model, but the total effect could be insignificant due to other reasons such as small sample size, assumptions for the test of the total effect have not been met and so on. These reasons make the causal step approach one of the least powerful tests of mediation (Preacher & Selig, 2012). Further, (c) when there are two mediators with comparable magnitude, but in the opposite direction, the total effect becomes zero. These mediators will be missed if causal step approach is being used.

Based on Hutchinson et al. (2008), when a general model is intervened by a third variable, it could be a mediator (*M*), a confounder (*C*), or a suppressor (*S*). The appropriateness of the conceptual frameworks requires being determined by the nature of the variables studied or by the purpose of the study. While mediators are capable of being changed and are often selected based on their flexibility, confounders are often demographic variables such as age, gender, and race that typically cannot be changed in an experimental design and suppressor variables may or may not be malleable. Mediational hypotheses imply causal relationships, and mediation analysis helps to identify the critical components of interventions (MacKinnon & Dwyer, 1993). Based on Susser (1973), Breslow and Day (1980), Meinert (1986) and Robins (1989), a confounding hypothesis suggests that a third variable explains the relationship between an independent and dependent variable.

However, MacKinnon et al. (2000) indicated that the confounding does not necessarily imply a causal relationship among the variables, unlike the mediational hypothesis.

When a third variable intervenes in a mediational context, the relationship between the independent and dependent variable reduces because the mediator explains a part or all of the relationship due to it causal path between the independent and dependent variables. The relationship also reduces between independent and dependent variables in a confounding context because the third intervening variable removes distortion due to the confounding variable (MacKinnon et al., 2000). However, as these authors pointed out, the magnitude of the relationship between an independent and dependent variable can become more substantial when a third variable intervenes. This situation is called suppression or inconsistent mediation. Tzelgov and Henik (1991), who indicated that a suppression variable is a variable that increases the predictive validity of another variable (or a set of variables) by its intervention in a relationship, present the accepted definition of suppressor variable. The predictive validity referred here by the authors indicates the magnitude of the regression coefficient. As indicated by Cliff and Earleywine (1994) and Tzelgov and Henik (1991), a suppression effect could present within a mediation model when the total and mediated effects of an independent variable on a dependent variable have opposite signs. Davis (1985) refer to the models with suppression variables as inconsistent mediation models.

The first criterion to fulfil for mediation analysis is significant paths (total effect, c) between independent and dependent variables. McFatter presented a hypothetical situation (1979) in which an inconsistent mediation (suppression) effect was present, but did not meet the first criterion for the mediation analysis. Therefore, MacKinnon et al.

(2000) concluded that the usual causal step approach conditions are only suitable for consistent mediation and not for inconsistent mediation.

Based on Hutchinson et al. (2008), in an exploratory study, mediation is the likely hypothesis, because the intervention is designed to change mediating variables that are hypothesised to be related to the outcome variable. The confounding effect is usually removed in the randomisation process. However, the authors added that a mediator might be disadvantageous, leading to an inconsistent mediation or a suppression effect. Therefore, if a variable is expected to increase effects when it is included with another predictor, then suppression is the likely model.

Therefore, the analysis is continued with the intervening variables 'firms' capability and cooperation' and 'firms' transformative actions'.

6.2.2.2. The Effect with Intervening Variables

Firm attributes regarding 'capability and cooperation' and 'transformative actions' were added to the model in figure 6.2 to test the intervention effect. Subsequently, PLS algorithm is run to estimate standardised path coefficients, and by using bootstrapping with 2000 replications, their standard deviation, t-values and p-values were computed. The direct effects of all the exogenous and intervening variables are presented in table 6.4. Direct effect represents (c') the path coefficients after introducing the intervening variables.

Table 6.4: Effect with Intervening Variables (Direct Effects, c')

Exogenous and Intervening Variables	Standardised Path Coefficient (β)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Firms' Capability -> Innovation Outcomes	0.363***	0.056	6.436	0.000
Firms' Transformational Actions -> Innovation Outcomes	0.262***	0.064	4.082	0.000
Information asymmetries -> Firms' Capability	0.043ns	0.039	1.126	0.260
Information asymmetries -> Firms' Transformational Actions	0.680***	0.029	23.606	0.000
Information asymmetries -> Innovation Outcomes	-0.206***	0.076	2.704	0.007
Infrastructure and Institution for Private Sources -> Firms' Capability	0.534***	0.039	13.656	0.000
Infrastructure and Institution for Private Sources -> Firms' Transformational Actions	0.248***	0.049	5.071	0.000
Infrastructure and Institution for Private Sources -> Innovation Outcomes	0.142**	0.056	2.536	0.011
Infrastructure and Institution for Public Sources -> Firms' Capability	0.281***	0.045	6.210	0.000
Infrastructure and Institution for Public Sources -> Firms' Transformational Actions	0.139***	0.046	3.055	0.002
Infrastructure and Institution for Public Sources -> Innovation Outcomes	0.230***	0.057	4.049	0.000
Other and Public Sources of Funding -> Firms' Capability	-0.085ns	0.052	1.634	0.102
Other and Public Sources of Funding -> Firms' Transformational Actions	-0.098**	0.040	2.451	0.014
Other and Public Sources of Funding -> Innovation Outcomes	-0.019ns	0.046	0.413	0.680

*, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels respectively. *ns* indicates not significant at 95% confidence level.

With the intervening variables, out of the 13 paths altogether, 10 of the direct effects are significant. 3 of them indicating the paths 'Information asymmetries to firms' capability and cooperation', 'Other and Public Sources of Funding to firms capability and cooperation' and 'Other and Public Sources of Funding to innovation outcomes' are insignificant. Intervening or mediating analysis outcome is presented in figure 6.3 and table 6.5.

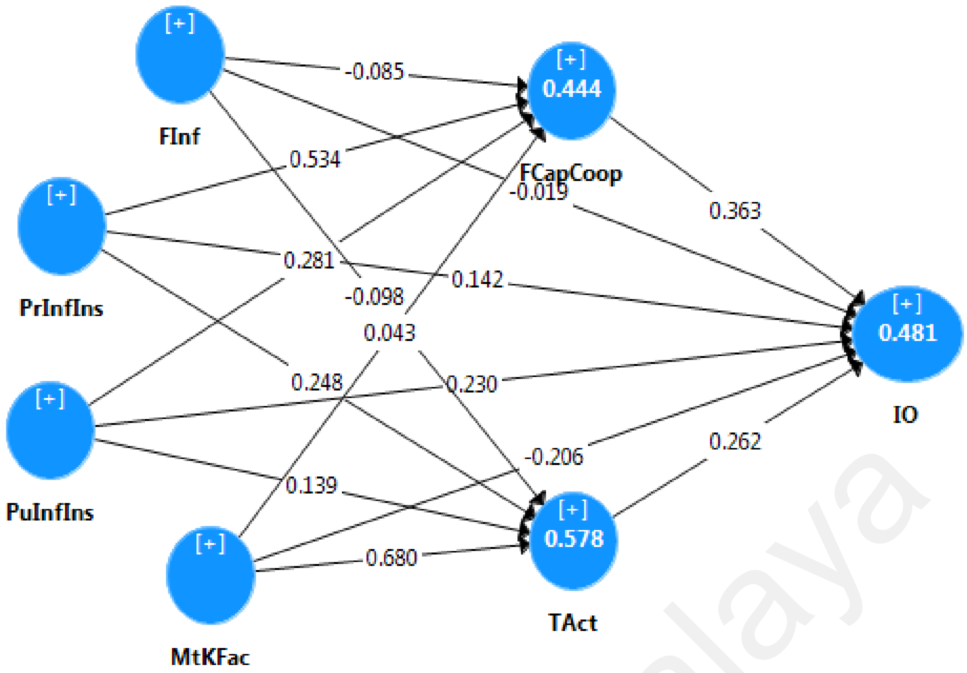

Figure 6.3: Model with Intervening Variables

Legend: PrInfIns – Private Infrastructure and Institution; FCapCoop – Firms' Capability including Cooperation; PuInfIns – Public (Government Support) Infrastructure and Institution; TAct – Firms' Transformational Actions; Finf – Funding Infrastructure; MtKFac – Market Knowledge Factor; IO – Innovation Outcomes.

Table 6.5: Mediation Analysis

Effects	**Path**	**Standardised Path Coefficient (β)**	**Indirect Effect**	**Standard Deviation**	**Total Effect**	**VAF**	**t-value**	**p-value**	**Decision**
Effect without mediator	Market Knowledge Factor ➔ Innovation Outcomes (c_1)	0.029^{ns}	NA	0.058	NA	NA	0.509	0.611	
Indirect Effect with a mediator	Market Knowledge Factor ➔ Firms' Capability and Cooperation (a_{11})	0.043^{ns}							
	Firms' Capability and Cooperation ➔ Innovation Outcomes (b_{11})	0.363^{***}							
	Market Knowledge Factor ➔ Firms' Transformative Actions (a_{12})	0.680^{***}							
	Firms' Transformative Actions ➔ Innovation Outcomes (b_{12})	0.262^{***}							
	Market Knowledge Factor ➔ Innovation Outcomes (c_1')	-0.206^{***}	0.194^{***}	0.049	-0.011	-1764%	3.989	0.000	Suppression (Inconsistent mediation)
Effect without mediator	Public Infrastructure and Institution ➔ Innovation Outcomes (c_2)	0.394^{***}	NA	0.087	NA	NA	4.542	0.000	
Indirect Effect with a mediator	Public Infrastructure and Institution ➔ Firms' Capability and Cooperation (a_{21})	0.281^{***}							
	Firms' Capability and Cooperation ➔ Innovation Outcomes (b_{21})	0.363^{***}							
	Public Infrastructure and Institution ➔ Firms' Transformative Actions (a_{22})	0.139^{***}							
	Firms' Transformative Actions ➔ Innovation Outcomes (b_{22})	0.262^{***}							
	Public Infrastructure and Institution ➔ Innovation Outcomes (c_2')	0.230^{***}	0.138^{***}	0.025	0.368	38%	5.460	0.000	Partial Mediation
Effect without mediator	Infrastructure and Institution for Private Sources ➔ Innovation Outcomes (c_3)	0.393^{***}	NA	0.099	NA	NA	3.966	0.000	

Effects	Path	Standardised Path Coefficient (β)	Indirect Effect	Standard Deviation	Total Effect	VAF	t-value	p-value	Decision
	'Table 6.5, continued'.								
Indirect Effect with a mediator	Infrastructure and Institution for Private Sources ➔ Firms' Capability and Cooperation (a_{31})	0.534^{***}							
	Firms' Capability and Cooperation ➔ Innovation Outcomes (b_{31})	0.363^{***}							
	Infrastructure and Institution for Private Sources ➔ Firms' Transformative Actions (a_{32})	0.248^{***}							
	Firms' Transformative Actions ➔ Innovation Outcomes (b_{32})	0.262^{***}							
	Infrastructure and Institution for Private Sources ➔ Innovation Outcomes (c_3')	0.142^{**}	0.259^{***}	0.044	0.401	65%	5.938	0.000	Partial Mediation
Effect without mediator	Funding Infrastructure ➔ Innovation Outcomes (c_4)	-0.021^{ns}	NA	0.065	NA	NA	0.322	0.747	
Indirect Effect with mediator	Funding Infrastructure ➔ Firms' Capability and Cooperation (a_{41})	-0.085^{ns}							
	Firms' Capability and Cooperation ➔ Innovation Outcomes (b_{41})	0.363^{***}							
	Funding Infrastructure ➔ Firms' Transformative Actions (a_{42})	-0.098^{**}							
	Firms' Transformative Actions ➔ Innovation Outcomes (b_{42})	0.262^{***}							
	Funding Infrastructure ➔ Innovation Outcomes (c_4')	-0.019^{ns}	-0.057^{*}	0.031	-0.076	75%	1.815	0.070	Partial Mediation

*, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels respectively. *ns* indicates not significant at 95% confidence level.

The significance of the indirect effect is used to evaluate the indirect effect. From table 6.5, it can be observed that:

(a) The indirect path between 'market knowledge factor' and 'innovation outcomes' through 'firms' capability and cooperation' and 'firms' transformative actions' together is significant with a t-value of 3.989 and a p-value of 0.0001 (which is less than 0.01). However, there is a change of direction in the path coefficients between without and with intervening variables ($\beta_{before} = 0.029$ and $\beta_{after} = -0.206$). Furthermore, the estimated VAF is -1764%, which is more than 100%. The estimated VAF is -1764% indicates that 1764% of the effect of 'market knowledge factor' on 'innovation outcomes' is explained negatively via firm attributes regarding 'firms' capability and cooperation' and 'firms' transformative actions'. Therefore, there is inconsistent mediation or suppression between the national contexts related 'market knowledge factor' and 'innovation outcomes' through the firm attributes 'capability and cooperation' and 'transformative actions', which act as suppressing agents here. 'Market knowledge factor' here reflects the unavailability of the information needed at the right time for innovation. When the information needed for innovation is not available in the national atmosphere, the effect of firm attributes on innovation outcomes is aggravated in a negative sense.

(b) The indirect path between 'public infrastructure and institution' and. 'innovation outcomes' through 'firms' capability and cooperation' and 'firms' transformative actions' together is significant with a t-value of 5.460 and a p-value of 0.0001 (which is less than 0.01). The estimated VAF is 38%, which indicates that 38% of the effect of 'public infrastructure and institution' on 'innovation outcomes' is explained via firm attributes regarding 'firms' capability and cooperation' and 'firms' transformative actions'. Since the VAF of 38% is between 20% and 80%, firm attributes ('firms' capability and cooperation' and 'firms' transformative actions') partially mediate the relationship between 'public infrastructure and institution' and 'innovation outcomes'.

(c) The indirect path between 'infrastructure and innovation for private sources' and 'innovation outcomes' through 'firms' capability and cooperation' and 'firms' transformative actions' together is significant with a t-value of 5.938 and a p-value of 0.0001 (which is less than 0.01). The estimated VAF is 65%, which indicates that 65% of the effect of 'infrastructure and institution for private sources' on 'innovation outcomes' is explained via firm attributes regarding 'firms' capability and cooperation' and 'firms' transformative actions'. Since the VAF of 65% is between 20% and 80%, firm attributes ('firms' capability and cooperation' and 'firms' transformative actions') partially mediate the relationship between 'infrastructure and institution for private sources' and 'innovation outcomes'.

(d) The indirect path between 'funding infrastructure' and 'innovation outcomes' through 'firms' capability and cooperation' and 'firms' transformative actions' together is significant with a t-value of 1.815 and a p-value of 0.070 (which is less than 0.10, 90% confidence level). The estimated VAF is 75%, which indicates that 75% of the effect of 'funding infrastructure' on 'innovation outcomes' is explained via firm attributes regarding 'firms' capability and cooperation' and 'firms' transformative actions'. Since the VAF of 75% is between 20% and 80%, firm attributes ('firms' capability and cooperation' and 'firms' transformative actions') partially mediate the relationship between 'funding infrastructure' and 'innovation outcomes'.

6.2.3. Explanatory Power of the Model

The explanatory power of the model is evaluated using the coefficient of determination (R^2). R^2 is used in statistical models with the objective to predict future outcomes or to test hypotheses. This coefficient is used to evaluate the predictive accuracy of the model and to assess how well the observed model fits the theoretical model. R^2 value shows the variance in the endogenous variable (innovation outcomes), which is explained by the exogenous variables in the model regressed to it. As it is shown in Table 6.6, the coefficient of determination of 'firms' capability and cooperation' is 44.4% and that of 'firms' transformative actions' is 57.8%. It indicates that 44.4% of the variation of firms' 'capability and cooperation' and 57.8% of the variation in 'firms' transformative actions' are explained by the national contextual factors 'market knowledge factor', 'public infrastructure and institution', 'infrastructure and institution for private sources' and 'funding infrastructure'. The R^2 value for 'innovation outcomes' is 48.1%, which indicates that 48.1% variation in 'innovation outcomes' is explained by all the exogenous and intervening variables in the model.

Table 6.6: Endogenous Variables and Related R^2

No	Endogenous Variables	R^2
1	Firms' Capability and Cooperation	44.4% ***
2	Firms' Transformational Actions	57.8%***
3	Innovation Outcomes	48.1%***

*, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels respectively. *ns* indicates not significant at 95% confidence level.

All the R^2 values satisfied the minimum requirement of the 10% cut off values and significant with substantial explanatory power indicating the predictive accuracy of the model for planning purposes. Above all, the variability explained by the endogenous constructs provided the model with a substantial nomological validity in the manufacturing sector of an emerging economy context of Malaysia, whereby large numbers of indifferent factors influence the ultimate dependent variable 'innovation outcomes'. However, the model specified here had sufficient merit as it explained about 48.1% of the variance in the innovation outcomes of firms.

6.2.4. Assessment of Effect Size

Effect size is used to assess the strength of a phenomenon. Based on Fritz, Morris, and Richler, (2012), estimates of effect size are useful for determining the practical or theoretical importance of an effect, the relative contribution of different factors or the same factor in different circumstances, and the power of analysis. In hypothetical models, the dependent and intervening variables are predicted by more than one predicting or intervening variable. According to Wong (2013), effect sizes as indicated as f^2 can be estimated to assess how much a predicting (exogenous) variable contributes to an endogenous latent variable's R^2 value by SmartPLS 3 bootstrapping procedure. According to Wong (2013), f^2 value of 0.02 shows a small effect, f^2 value of 0.15 shows a medium effect, and f^2 value of 0.35 shows a large effect. The f^2 values estimated are presented below in Table 6.7.

Table 6.7: Effect Size for Variables (f^2)

No	Exogenous Variables	Intervening / Endogenous Variables		
		Firms' Capability and Cooperation	Firms' Transformative Actions	Innovation Outcomes
1	Market Knowledge Factor	0.003	1.070 (large)	0.038 (small)
2	Public Infrastructure and Institution	0.117(small)	0.038 (small)	0.073 (small)
3	Infrastructure and Institution for Private Sources	0.454 (large)	0.129 (small)	0.022 (small)
4	Funding Infrastructure	0.011	0.020 (small)	0.001
5	Firms' Capability and Cooperation			0.139 (small)
6	Firms' Transformative Actions			0.055 (small)

Mostly the effect sizes are small except for a few. 'Market knowledge factors' has an extra-large effect on 'firms' transformative action' and less than 0.02 effect on 'firms' capability and cooperation. 'Infrastructure and institution for private sources' has a large effect on 'firms' capability and cooperation' variable. However, 'funding infrastructure' has less than 0.02 effect on both 'firms' capability and cooperation' and 'innovation outcomes'. Both the intervening variables have a small effect on the 'innovation outcomes'. In general, all the predicting variables have contributed (ranging from small to large effect) to the endogenous variable 'innovation outcomes'.

6.2.5. Assessment of Predictive Relevance

Predictive relevance indicates how accurately the model can predict innovation outcomes as an endogenous construct in the model. Based on Geisser (1974) and Stone (1974), the magnitude of the coefficient of determination as a criterion of predictive accuracy can be assessed using Stone-Geisser's Q^2 effect size. Based on Hair *et al.* (2013), Q^2 is a measure of the predictive accuracy and relevance of the model. The two different methods available to estimate Q^2 value are the cross-validated redundancy, and the cross-validated communality approaches. While the cross-validated communality approach estimates the value using only the measurement model, cross-validated redundancy approach uses both path models of the structural model and the measurement model respectively. Hence, this research used the cross-validated redundancy approach to compute Stone-Geisser's Q^2 effect size as suggested by Chin (2010). A Q^2 greater than zero implies that the model has predictive relevance, whereas a Q^2 less than zero suggests that the model lacks predictive relevance (Chin, 1988). Blindfolding procedure in SmartPLS is used to estimate the Q^2 values and are presented in Table 6.8.

Table 6.8: Predictive Relevance for Endogenous Variables

No	Endogenous Variables	Q^2
1	Firms' Capability and Cooperation	16%
2	Firms' Transformational Actions	33.7%
3	Innovation Outcomes	11.3%

Since all Q^2 values of all intervening and endogenous variables are more than zero, all of them have predictive relevance.

6.2.6. Summary of the Results

The results obtained from the analysis of the structural model of manufacturing sector demonstrated one inconsistent and three partial mediation effects. The model also emerged as a relatively parsimonious model. The model is with substantial explanatory power indicating the predictive accuracy of the model for planning purposes with all the R^2 values significant and above the minimum requirement of the 10% cut off value. All the predicting variables have contributed (ranging from small to large effect) to the endogenous variable ‘innovation outcomes’ with a large effect of ‘market knowledge factor’ on ‘firms’ transformative actions’ and ‘institution and infrastructure for private sources’ on ‘firms’ capability and cooperation’. The proposed model also has the good predictive ability with the entire Q^2 values above zero. The following section discusses the structural analysis done in the services sector.

6.3. Structural (Inner Model) Analysis for Services Sector

The structural analysis of the proposed model for services sector was done based on the five steps structural model assessment advocated by Hair et al. (2013) as indicated in figure 6.1. As indicated in the previous section, the assessment of structural (inner) model requires reliable and valid measurement (outer) model estimates as per Henseler et al. (2009). The reliability and validity of the measurement model estimates for services sector are established and summarised in chapter 4.

6.3.1. Assessment of Collinearity Issue

This research examined the correlation among ‘market knowledge factor’, ‘funding infrastructure’, ‘government support infrastructure and institution’, and ‘knowledge infrastructure’ as exogenous variables and firm attributes ‘resource capability’, ‘financial capability’, ‘cooperation’ and ‘transformative actions’ as the mediator to evaluate correlation and collinearity issue. Their VIF and tolerance are also estimated. The analysis is done by using SmartPLS, and latent variable scores for each construct was computed. These values are used for collinearity assessment among variables. Correlation matrix for exogenous variables and the mediator are shown in Table 6.9. From the table, it can be seen these correlation coefficients range from -0.081 to 0.691 and are below 0.8, which indicate that there is no high correlation among variables as per Field (2013) except for the correlation between 'knowledge infrastructure' and 'firms' cooperation'. The correlation coefficient here is 0.892, which is above the threshold. However, further evaluation based on VIF and tolerance showed that there is no collinearity issue as shown in table 6.10.

Table 6.9: Correlation among the Exogenous and Mediating Variables

	Firms' Cooperation	Firms' Financial Capability	Firms' Resource Capability	Firms' Transformational Actions	Funding Infrastructure	Government Support Infrastructure and Institution	Knowledge Infrastructure	Market Knowledge Factor
Firms' Cooperation	1.000							
Firms' Financial Capability	0.010	1.000						
Firms' Resource Capability	-0.005	0.071	1.000					
Firms' Transformational Actions	0.005	0.030	-0.009	1.000				
Funding Infrastructure	0.017	0.008	0.073	-0.041	1.000			
Government Support Infrastructure and Institution	-0.071	0.062	0.092	-0.066	-0.015	1.000		
Knowledge Infrastructure	0.892	-0.016	-0.009	0.004	0.018	-0.081	1.000	
Market Knowledge Factor	0.075	0.032	0.035	0.691	-0.015	-0.024	0.062	1.000

Table 6.10: VIF and Tolerance Values for Exogenous and Mediating Variables

Mediating and Exogenous Variables	**Firms' Cooperation**		**Firms' Financial Capability**		**Firms' Resource Capability**		**Funding Infrastructure**		**Innovation Outcomes as the dependent variable**	
	VIF	**Tolerance**	**VIF**	**Tolerance**	**VIF**	**Tolerance**	**VIF**	**Tolerance**	**VIF**	**Tolerance**
Firms' Cooperation									4.907	0.204
Firms' Financial Capability									1.012	0.988
Firms' Resource Capability									1.021	0.979
Firms' Transformational Actions									1.938	0.516
Funding Infrastructure	1.001	0.999	1.001	0.999	1.001	0.999	1.001	0.999	1.008	0.992
Government Support Infrastructure and Institution	1.007	0.993	1.007	0.993	1.007	0.993	1.007	0.993	1.024	0.976
Knowledge Infrastructure	1.011	0.990	1.011	0.990	1.011	0.990	1.011	0.990	4.899	0.204
Market Knowledge Factor	1.004	0.996	1.004	0.996	1.004	0.996	1.004	0.996	1.941	0.515

The VIF of variables vary between 1.001 and 4.907 and are below five (Hair *et al.*, 2011; Myers, 1990). Also, tolerance values vary between 0.204 and 0.999 and are above 0.2 (Hair *et al.*, 2011; Menard, 1995). Since there is no collinearity problem; the predictor constructs are not biased.

6.3.2. Significance and Relevance of Structural Model Relationships

Once the collinearity issues are evaluated and cleared, the significance and relevance of the relationships as stipulated in the structural model are assessed to test the proposed hypotheses. This assessment is done using standardised path coefficients estimated by PLS algorithm. Subsequently, bootstrapping is run with 2000 replications to estimate the standard deviation of path coefficients, *t*-value and p-value for each path in their respective model.

6.3.2.1. Effect without Intervening Variables

The third objective discussed here aims to test the intervening effect of the national contextual factors on the innovation outcomes through firm attributes. The first step is to examine the total effect. Total effect represents the path coefficient (c) before introducing the mediating variables into the model. Therefore, a model is developed by regressing from exogenous variables ('government support infrastructure and institution', 'knowledge infrastructure', 'funding infrastructure' and 'market knowledge factor') on innovation outcomes without the intervening firm related variables ('financial capability', 'resource capability', 'cooperation' and 'transformative actions'). The model without the intervening variables is shown in Figure 6.4.

Standardised path coefficients (β), their respective standard deviation, *t*-value and *p*-value estimated by running PLS method and bootstrapping with 2000 replications, are reported in Table 6.11. Mediation analysis is carried out with a slight modification to the guidelines proposed for mediation analysis in PLS-SEM by Hair et al. (2014). Based on the guidelines, the significance of the path without the intervening variables (total effect, c) is evaluated. Then the intervening variables are introduced to the model and bootstrapping is done to analyse the mediation or intervention. If the indirect effect was significant, the variance accounted for (VAF) was calculated. A VAF value of greater than 80% is full mediation, a value between 20% and 80% is partial mediation and a value less than 20% means there is no mediation (Hair et al., 2014).

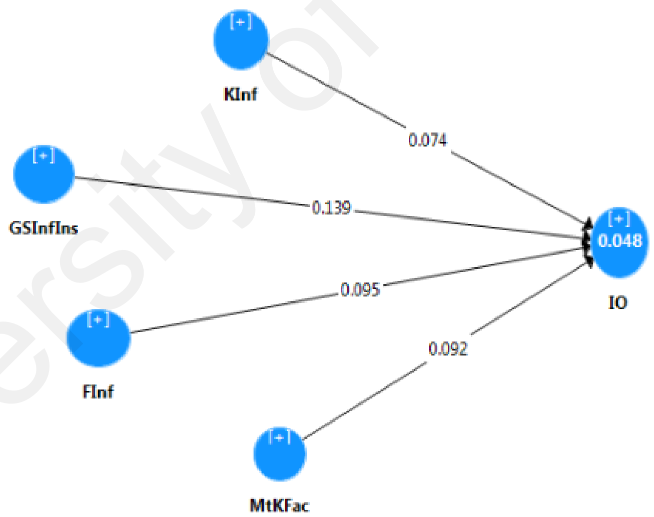

Figure 6.4: Model without Intervening Variables

Legend: KInf – Knowledge Infrastructure; GSInfIns – Government Support Infrastructure and Institution; Finf – Funding Infrastructure; MtKFac – Market Knowledge Factor; IO – Innovation Outcomes.

Table 6.11: Effect without the Intervening Variables (Total Effect, c)

Exogenous Variables to Innovation Outcomes (R^2 = 4.5%; Q^2 = -0.4%)	Standardised Path Coefficient (β)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Funding Infrastructure -> Innovation Outcomes	0.095	0.127	0.746	0.456
Government Support Infrastructure and Institution -> Innovation Outcomes	0.139	0.088	1.576	0.115
Knowledge Infrastructure -> Innovation Outcomes	0.074	0.122	0.607	0.544
Market Knowledge Factor -> Innovation Outcomes	0.092	0.103	0.895	0.371

*, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels respectively. *ns* indicates not significant at 95% confidence level.

Figure 6.4 and table 6.11 illustrated that none of the four relationships between exogenous and dependent variable is significant. The coefficient of determination, R^2, is 0.045 for the Innovation Outcomes (IO) endogenous latent variable, which means that the four exogenous variables considered here very weakly explain 4.5% of the variance in IO. The findings showed that R^2 score of endogenous construct's (innovation outcomes) value did not satisfy the minimum requirement for the 0.10 cut off value, which had been the indication of a relatively parsimonious model as per Hanlon (2001) and Mustamil (2010). Also, the measure of predictive relevance is -0.4%. Since the Q^2 value is less than zero, it suggests that the model lacks predictive relevance.

Based on Hair et al. (2014), if the total effect is not significant without the mediating variables, there is no mediation. In general, the first criterion to fulfil for mediation analysis is significant paths (total effect, c) between independent and dependent variables. However, based on the discussion earlier, due to lack of conceptual and empirical understanding in this area, this study assumed that there could be intervention in the relationship between national contextual factors and innovation outcomes even if the total effect (c) is not significant. This decision is also based on the discussions of Hayes (2009), MacKinnon et al. (2000), Mackinnon et al. (2004) and Preacher and Selig (2012) and many other authors. These authors highlighted a broad consensus among statisticians that the total effect (*c*) (which is used in causal step approach) should not be used as a qualifying criterion for tests of mediation. McFatter presented a hypothetical situation (1979) in which an inconsistent mediation (suppression) effect was present, but did not meet the first criterion for the mediation analysis. Therefore, MacKinnon et al. (2000) concluded that the usual causal step approach conditions are only suitable for consistent mediation and not for inconsistent mediation.

Based on Hutchinson et al. (2008), when a third variable intervenes a general model, it could be a mediator (*M*), a confounder (*C*), or a suppressor (*S*). The appropriateness of the conceptual frameworks requires being determined by the nature of the variables studied or by the purpose of the study. Based on Hutchinson et al. (2008), in an exploratory study, mediation is the likely hypothesis, because the intervention is designed to change mediating variables that are hypothesised to be related to the outcome variable. The confounding effect is usually removed in the randomisation process. However, the authors added that a mediator might be disadvantageous, leading to an inconsistent mediation or a suppression effect. Therefore, if a variable is expected to increase effects when it is included with another predictor, then suppression is the likely model. Therefore, the analysis was continued with the intervening variables 'firms' financial capability', 'firms' resource capability', 'firms' cooperation' and 'firms' transformative actions'.

6.3.2.2. The Effect with Intervening Variables

Firm attributes regarding 'financial capability', 'resource capability', 'cooperation' and 'transformative actions' were added to the model in figure 6.4 to test the intervention effect. Subsequently, PLS algorithm is run to estimate standardised path coefficients, and by using bootstrapping with 2000 replications, their standard deviation, t-values and p-values were computed. The direct effects of all the exogenous and intervening variables are presented in table 6.12. Direct effect represents (c') the path coefficients after introducing the intervening variables.

Table 6.12: Effect with Intervening Variables (Direct Effects, c')

	Original Sample (O)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Firms' Cooperation -> Innovation Outcomes	-0.029^{ns}	0.088	0.328	0.743
Firms' Financial Capability -> Innovation Outcomes	-0.035^{ns}	0.036	0.951	0.342
Firms' Resource Capability -> Innovation Outcomes	0.498^{***}	0.031	16.274	0.000
Firms' Transformational Actions -> Innovation Outcomes	0.047^{ns}	0.060	0.783	0.434
Funding Infrastructure -> Firms' Cooperation	0.001^{ns}	0.018	0.046	0.963
Funding Infrastructure -> Firms' Financial Capability	0.010^{ns}	0.069	0.143	0.887
Funding Infrastructure -> Firms' Resource Capability	0.075^{ns}	0.050	1.485	0.138
Funding Infrastructure -> Firms' Transformational Actions	-0.030^{ns}	0.039	0.771	0.441
Funding Infrastructure -> Innovation Outcomes	0.043^{ns}	0.050	0.846	0.398
Government Support Infrastructure and Institution -> Firms' Cooperation	0.002^{ns}	0.016	0.109	0.913
Government Support Infrastructure and Institution -> Firms' Financial Capability	0.062^{ns}	0.040	1.553	0.120
Government Support Infrastructure and Institution -> Firms' Resource Capability	0.093^{**}	0.041	2.276	0.023
Government Support Infrastructure and Institution -> Firms' Transformational Actions	-0.054^{ns}	0.039	1.388	0.165
Government Support Infrastructure and Institution -> Innovation Outcomes	0.019^{ns}	0.043	0.426	0.670
Knowledge Infrastructure -> Firms' Cooperation	0.890^{**}	0.357	2.497	0.013
Knowledge Infrastructure -> Firms' Financial Capability	-0.013^{ns}	0.037	0.352	0.725
Knowledge Infrastructure -> Firms' Resource Capability	-0.006^{ns}	0.036	0.154	0.878
Knowledge Infrastructure -> Firms' Transformational Actions	-0.043^{ns}	0.031	1.364	0.173
Knowledge Infrastructure -> Innovation Outcomes	0.006^{ns}	0.085	0.065	0.948
Market Knowledge Factor -> Firms' Cooperation	0.020^{ns}	0.019	1.055	0.291

'Table 6.12, continued'.

Market Knowledge Factor -> Firms' Financial Capability	0.034^{ns}	0.037	0.923	0.356
Market Knowledge Factor -> Firms' Resource Capability	0.039^{ns}	0.039	1.000	0.317
Market Knowledge Factor -> Firms' Transformational Actions	0.692^{***}	0.023	29.790	0.000
Market Knowledge Factor -> Innovation Outcomes	-0.028^{ns}	0.056	0.497	0.619

*, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels respectively. *ns* indicates not significant at 95% confidence level.

With the intervening variables, out of the 24 paths altogether, only four (4) of the direct effects are significant. They are the paths between Firms' Resource Capability -> Innovation Outcomes, Government Support Infrastructure and Institution -> Firms' Resource Capability, Knowledge Infrastructure -> Firms' Cooperation, and Market Knowledge Factor -> Firms' Transformational Actions. Intervening or mediating analysis outcome is presented in figure 6.5 and table 6.13.

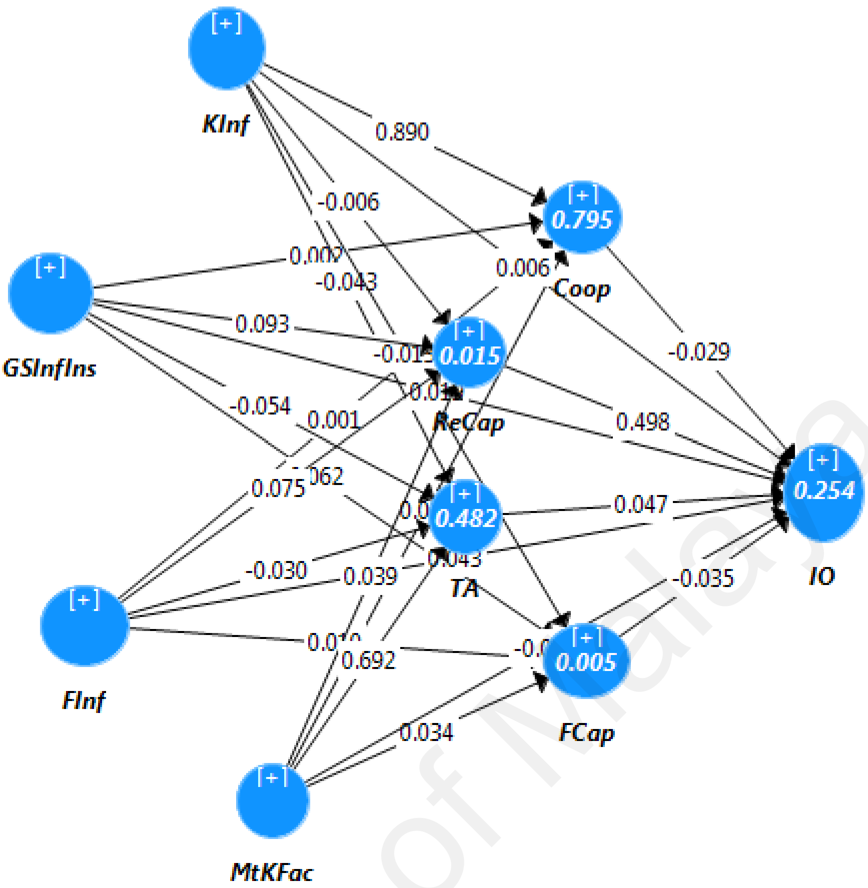

Figure 6.5: Model with Intervening Variables

Legend: KInf – Knowledge Infrastructure; GSInfIns – Government Support Infrastructure and Institution; Finf – Funding Infrastructure; MtKFac – Market Knowledge Factor; TA –Transformational Actions; Coop –Cooperation; ReCap – Resource Capability; FCap – Financial Capability; IO – Innovation Outcomes.

Table 6.13: Mediation Analysis

Effects	Path	Standardised Path Coefficient (β)	Indirect Effect	Standard Deviation	t-value	p-value	Total Effect	VAF	Decision
Effect without intervention	Funding Infrastructure -> Innovation Outcomes (c_1)	0.095^{ns}							
Effect with intervention	Firms' Cooperation -> Innovation Outcomes	-0.029^{ns}							
	Firms' Financial Capability -> Innovation Outcomes	-0.035^{ns}							
	Firms' Resource Capability -> Innovation Outcomes	0.498^{***}							
	Firms' Transformational Actions -> Innovation Outcomes	0.047^{ns}							
	Funding Infrastructure -> Firms' Cooperation	0.001^{ns}							
	Funding Infrastructure -> Firms' Financial Capability	0.010^{ns}							
	Funding Infrastructure -> Firms' Resource Capability	0.075^{ns}							
	Funding Infrastructure -> Firms' Transformational Actions	-0.030^{ns}							
	Funding Infrastructure -> Innovation Outcomes (c_1')	0.043^{ns}	0.035^{ns}	0.026	1.366	0.172	0.078	45%	Intervention is not supported
Effect without intervention	Government Support Infrastructure and Institution -> Innovation Outcomes (c_2)	0.139^{ns}							
Effect with intervention	Firms' Cooperation -> Innovation Outcomes	-0.029^{ns}							
	Firms' Financial Capability -> Innovation Outcomes	-0.035^{ns}							

‘Table 6.13, continued’.

Effects	Path	Standardised Path Coefficient (β)	Indirect Effect	Standard Deviation	t-value	p-value	Total Effect	VAF	Decision
	Firms' Resource Capability -> Innovation Outcomes	0.498^{ns}							
	Firms' Transformational Actions -> Innovation Outcomes	0.047^{ns}							
	Government Support Infrastructure and Institution -> Firms' Cooperation	0.002^{ns}							
	Government Support Infrastructure and Institution -> Firms' Financial Capability	0.062^{ns}							
	Government Support Infrastructure and Institution -> Firms' Resource Capability	0.093^{**}							
	Government Support Infrastructure and Institution -> Firms' Transformational Actions	-0.054^{ns}							
	Government Support Infrastructure and Institution -> Innovation Outcomes (c_2’)	0.019^{ns}	0.042^{*}	0.022	1.925	0.054	0.060	69%	Partial Mediation
Effect without intervention	Knowledge Infrastructure -> Innovation Outcomes (c_3)	0.074^{ns}							
Effect with intervention	Firms' Cooperation -> Innovation Outcomes	-0.029^{ns}							
	Firms' Financial Capability -> Innovation Outcomes	-0.035^{ns}							
	Firms' Resource Capability -> Innovation Outcomes	0.498^{ns}							
	Firms' Transformational Actions -> Innovation Outcomes	0.047^{ns}							
	Knowledge Infrastructure -> Firms' Cooperation	0.890^{**}							

‘Table 6.13, continued’.

Effects	Path	Standardised Path Coefficient (β)	Indirect Effect	Standard Deviation	t-value	p-value	Total Effect	VAF	Decision
	Knowledge Infrastructure -> Firms' Financial Capability	-0.013^{ns}							
	Knowledge Infrastructure -> Firms' Resource Capability	-0.006^{ns}							
	Knowledge Infrastructure -> Firms' Transformational Actions	-0.043^{ns}							
	Knowledge Infrastructure -> Innovation Outcomes (c_3’)	0.006^{ns}	-0.030^{ns}	0.080	0.377	0.706	-0.024	123%	Inconsistent mediation noted. However, it is not supported
Effect without intervention	Market Knowledge Factor -> Innovation Outcomes (c_4)	0.092^{ns}							
Effect with intervention	Firms' Cooperation -> Innovation Outcomes	-0.029^{ns}							
	Firms' Financial Capability -> Innovation Outcomes	-0.035^{ns}							
	Firms' Resource Capability -> Innovation Outcomes	0.498^{ns}							
	Firms' Transformational Actions -> Innovation Outcomes	0.047^{ns}							
	Market Knowledge Factor -> Firms' Cooperation	0.020^{ns}							
	Market Knowledge Factor -> Firms' Financial Capability	0.034^{ns}							
	Market Knowledge Factor -> Firms' Resource Capability	0.039^{ns}							
	Market Knowledge Factor -> Firms' Transformational Actions	0.692***							

‘Table 6.13, continued’.

Effects	Path	Standardised Path Coefficient (β)	Indirect Effect	Standard Deviation	t-value	p-value	Total Effect	VAF	Decision
	Market Knowledge Factor -> Innovation Outcomes (c_4’)	-0.028^{ns}	0.051^{ns}	0.047	1.064	0.288	0.023	223%	Inconsistent mediation noted. Nevertheless, it is not supported.

*, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels respectively. *ns* indicates not significant at 95% confidence level.

The significance of the indirect effect is used to evaluate the mediation effect. From the table 6.13, it can be observed that there is only one significant indirect path (Government Support Infrastructure and Institution -> Innovation Outcomes) among the four proposed in the model.

(a) The indirect path between 'government support infrastructure and institution' and 'innovation outcomes' through firm attributes 'resource capability', 'financial capability', 'cooperation' and 'transformative actions' is significant at 90% confidence with a t-value of 1.925 and a p-value of 0.06 (which is less than 0.10). The estimated VAF is 69%, which indicates that 69% of the effect of 'government support infrastructure and institution' on 'innovation outcomes' is explained via the four firm attributes mentioned here. Since the VAF of 69% is between 20% and 80%, firm attributes ('resource capability', 'financial capability', 'cooperation' and 'transformative actions' together) partially mediate the relationship between 'government support infrastructure and institution' and 'innovation outcomes'.

(b) Based on the VAF value (more than 100%), suppression effect is noted in the paths Knowledge Infrastructure -> Innovation Outcomes (VAF = 123%) and Market Knowledge Factor -> Innovation Outcomes (223%). Since the indirect effect is not significant, the result needs further investigation.

6.3.3. Explanatory Power of the Model

The explanatory power of the model is evaluated using the coefficient of determination (R^2). R^2 is used in statistical models with the objective to predict future outcomes or to test hypotheses. This coefficient is used to evaluate the predictive accuracy of the model and to assess how well the observed model fits the theoretical model. R^2 value shows the variance in the endogenous variable (innovation outcomes), which is explained by the exogenous variables in the model regressed to it. As it is shown in table 6.14, the coefficient of determination of 'firms' cooperation' and that of 'firms' transformative actions' are 79.5% and 48.2%, which are more than the stipulated threshold of 10%. However, firms' 'resource capability' and 'financial capability' have R^2 values of 1.5% and 0.5% respectively. It indicates that 79.5% of the variation of 'firms' cooperation', 48.2% of the variation in 'firms' transformative actions', 1.5% variation in the 'resource capability' and 0.5% variation in 'financial capability' are explained by the national contextual factors 'market knowledge factor', 'government support infrastructure and institution', 'knowledge infrastructure' and 'funding infrastructure'. It is evident from here that the national contextual factors explain firms' 'cooperation' and 'transformative actions' substantially, they do not much explain firms' 'resource capability' and 'financial capability'. The R^2 value for 'innovation outcomes' is 25.4%, which indicates that 25.4% variation in 'innovation outcomes' is explained by all the exogenous and intervening variables in the model.

Table 6.14: Endogenous Variables and Related R^2

No	Endogenous Variables	R^2
1	Firms' Cooperation	79.5%***
2	Firms' Financial Capability	0.5%ns
3	Firms' Resource Capability	1.5%ns
4	Firms' Transformational Actions	48.2%***
5	Innovation Outcomes	25.4%***

*, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels respectively. *ns* indicates not significant at 95% confidence level.

The findings showed that R^2 score of final endogenous construct (innovation outcomes) value satisfied the minimum requirement for the 0.10 cut off value, which had been the indication of a relatively parsimonious model as per Hanlon (2001) and Mustamil (2010).

Above all, the variability explained by the endogenous constructs provided the model with a substantial nomological validity in the services sector of an emerging economy context of Malaysia, whereby large numbers of indifferent factors influence the ultimate dependent variable 'innovation outcomes'. However, the model specified here had adequate merit as it explained about 25.4% of the variance in the innovation outcomes of firms.

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6.3.4. Assessment of Effect Size

Effect size is used to assess the strength of a phenomenon. Based on Fritz et al., (2012), estimates of effect size are useful for determining the practical or theoretical importance of an effect, the relative contribution of different factors or the same factor in different circumstances, and the power of analysis. In hypothetical models, the dependent and intervening variables are predicted by more than one predicting or intervening variable. According to Wong (2013), effect sizes as indicated as f^2 can be estimated to assess how much a predicting (exogenous) variable contributes to an endogenous latent variable's R^2 value by SmartPLS 3 bootstrapping procedure. The author also provided a rule of thumb indicating that f^2 value of 0.02 shows a small effect, f^2 value of 0.15 shows a medium effect, and f^2 value of 0.35 shows a large effect. The f^2 values estimated are presented below in table 6.15.

Table 6.15: Effect Size for Variables (f^2)

No	Exogenous Variables	Intervening / Endogenous Variables				
		Firms' Cooperation	**Firms' Resource Capability**	**Firms' Financial Capability**	**Firms' Transformative Actions**	**Innovation Outcomes**
1	Market Knowledge Factor	0.002 (small)	0.002 (small)	0.001 (small)	0.920 (large)	0.001 (small)
2	Government Support Infrastructure and Institution	0.000	0.009 (small)	0.004 (small)	0.006 (small)	0.000
3	Knowledge Infrastructure	3.835 (large)	0.000	0.000	0.004 (small)	0.000
4	Funding Infrastructure	0.000	0.006 (small)	0.000	0.002 (small)	0.002 (small)
5	Firms' Cooperation					0.000
	Firms' Resource Capability					0.326 (medium)
	Firms' Financial Capability					0.002 (small)
6	Firms' Transformative Actions					0.002 (small)

The effect sizes are small in general with a value of less than 0.02 except for a few. The effect size of 'Market knowledge factor' on 'firms' transformative action' is large with the f^2 value of 0.920. The same goes for 'knowledge infrastructure' to 'firms' cooperation' with f^2 value of 3.835 indicating a huge effect. 'Firms' resource capability' has a medium effect (f^2 value of 0.326) on innovation outcomes.

6.3.5. Assessment of Predictive Relevance

Predictive relevance indicates how accurately the model can predict innovation outcomes as an endogenous construct in the model. Based on Geisser (1974) and Stone (1974), the magnitude of the coefficient of determination as a criterion of predictive accuracy can be assessed using Stone-Geisser's Q^2 effect size. Based on Hair *et al.* (2013), Q^2 is a measure of the predictive accuracy and relevance of the model. The two different methods available to estimate Q^2 value are the cross-validated redundancy, and the cross-validated communality approaches. While the cross-validated communality approach estimates the value using only the measurement model, cross-validated redundancy approach uses both path models of the structural model and the measurement model respectively. Hence, this research used the cross-validated redundancy approach to compute Stone-Geisser's Q^2 effect size as suggested by Chin (2010). A Q^2 greater than zero implies that the model has predictive relevance, whereas a Q^2 less than zero suggests that the model lacks predictive relevance (Chin, 1988). Blindfolding procedure in SmartPLS is used to estimate the Q^2 values and are presented in Table 6.16.

Table 6.16: Predictive Relevance for Endogenous Variables

No	Endogenous Variables	Q^2
1	Firms' Cooperation	18.3%
2	Firms' Financial Capability	-0.7%
3	Firms' Resource Capability	0.5%
4	Firms' Transformational Actions	27.6%
5	Innovation Outcomes	1.6%

All Q^2 values of all intervening and endogenous variables are more than zero except for 'firms' financial capability'.

6.3.6. Summary of the Results

The results obtained from the analysis of the structural model of services sector demonstrated one partial mediation among the four interventions tested. The model specified here had adequate merit overall as it explained about 25.4% of the variance in the innovation outcomes of firms, significant and above the minimum requirement of the 10% cut off value. All the predicting variables have contributed (ranging from small to large effect) to the endogenous variable 'innovation outcomes' with a large effect of 'market knowledge factor' on 'firms' transformative actions' and 'knowledge infrastructure' on 'firms' cooperation'. The proposed model also has the good predictive ability with all the Q^2 values above zero except for 'financial capability'.

6.4. Comparison between Manufacturing and Services Sectors

When the structural models proposed in this study for manufacturing and services sectors are compared, the contextual factors (three of them with partial mediation and one with suppression effect) establish indirect influence on innovation outcomes in the manufacturing sector. However, the contextual factors in services sectors do not establish the indirect effect on innovation outcomes except for government support infrastructure and institution (partial mediation). The structural model proposed showed higher explanatory power with higher predictive accuracy for manufacturing sector compared to the services sector. Also, the predictive relevance of all the endogenous variables is established in both the sectors except for 'financial capability' in the services sector. Based on Leiponen and Drejer (2007), inter-industry differences are considerably noticeable compared to within-industry differences. This difference is evident in the structural models of manufacturing and services sectors. Leiponen and Drejer (2007) also indicated that it is not advisable to make generalisations about the economy as a whole based on results for manufacturing sector alone.

As explained earlier, since the firms in services sector belong to mostly small (46%) to medium (37%) sized firms, innovation is not the priority, it is reflected in their activities and has influenced the relationships. The possible reason for the national contexts not being able to influence firms in services sector could be because of the focus of NIS to the manufacturing sector and most of the policies are directed towards the manufacturing sector (Tien, 2007). However, the importance of the services sector cannot be overstated; it employs a large and growing proportion of workers in the industrialised nations (Tien, 2007).

6.5. Research Findings

The summary and discussion of the results of hypothesis 3 are presented below. Hypothesis 3 attempted to answer the third research issue presented above by empirically examining the indirect influence of the measures of NIS regarding national contexts on innovation outcomes through firm attributes, which can be comprehensively governed at the national level to enhance innovation outcomes. National innovation outcomes can be administered well if the relationship of national contexts or environments with innovation outcomes through firms is well understood. The summary of the findings and the discussion on the findings are presented below.

6.5.1. Summary of Findings

Research question 3, the associated main hypothesis and sub-hypotheses are presented in table 6.17 with the results and a general remark on the contribution to the theory.

Table 6.17: Summary of the Findings for Research Question 3

	Research Questions		Research Hypotheses	Conclusion	Contribution
RQ 3.0:	**What are the relationships among national contextual factors, firm related factors and innovation outcomes? How do they differ between manufacturing and services sectors?**	**$H_{3.0}$:**	**The effect of NIS contextual factors on innovation outcomes is intervened by firm attributes**	**The findings support an indirect effect of specific contextual dimensions on innovation outcomes through the firm attributes. However, there are differences between the sectors.** **Therefore, $H_{3.0}$ is supported.**	**A significant contribution to theory and practice regarding establishing the relationship between contextual dimensions and innovation outcomes through firm attributes. It further contributed by differentiating this relationship between manufacturing and services sector.**
rq 3.1:	What are the relationships of firm attributes and contextual factors with innovation outcomes in the manufacturing sector?	$H_{3.1}$:	The effect of NIS contextual factors on innovation outcomes is intervened by firm attributes in the manufacturing sector.	The findings established the below for manufacturing sector: • 'Market Knowledge Factor' has an inconsistent mediation or suppression effect on 'innovation outcomes' through the intervention of 'firms' capability and cooperation' and 'firms' transformative actions'. • 'Public Infrastructure and Institution' or 'Government Support Infrastructure and Institution' has an indirect influence on 'innovation outcomes' through the partial mediation of 'firms' capability and cooperation' and 'firms' transformative actions'. • 'Infrastructure and Institution for Private Sources' has an indirect influence on 'innovation outcomes' through the partial mediation of 'firms' capability and cooperation' and 'firms' transformative actions'. • 'Funding Infrastructure' has an indirect influence on 'innovation outcomes' through the partial mediation of 'firms' capability and cooperation' and 'firms' transformative actions'. Therefore, $H_{3.1}$ is supported.	

‘Table 6.17, continued’.

	Research Questions		Research Hypotheses	Conclusion	Contribution
rq 3.2:	What are the relationships of firm attributes and contextual factors with innovation outcomes in services sector?	$H_{3.2}$:	The effect of NIS contextual factors on innovation outcomes is intervened by firm attributes in the services sector.	The findings established the below for services sector: • ‘Public Infrastructure and Institution’ or ‘Government Support Infrastructure and Institution’ has an indirect influence on ‘innovation outcomes’ through the partial mediation of ‘firms’ ‘financial capability’, ‘resource capability’, ‘cooperation’ and ‘transformative actions’. The other contextual factors of the services sector regarding ‘funding infrastructure’, ‘knowledge infrastructure’ and ‘market knowledge factor’ did not establish any relationship with innovation outcomes. Therefore, $H_{3.2}$ is partly supported.	
rq 3.3:	How do manufacturing and services sector differ in the relationships of firm attributes and contextual factors with innovation outcomes?	$H_{3.3}$:	There is a difference between manufacturing and services sectors in the effect of NIS contextual factors on innovation outcomes intervened by firm attributes.	There are differences between manufacturing and services sectors in the effect of national contextual factors on innovation outcome through firm attributes. The model established in the study showed higher explanatory power and predictive relevance in the manufacturing sector compared to the services sector. Therefore, $H_{3.3}$ is supported.	

6.5.2. Discussion of Findings

This section discusses the findings of the investigation related to research issue 3 through hypothesis 3 on the effect of national contextual attributes on innovation outcomes through firm attributes.

6.5.2.1. Research Issue 3.1
What are the effects of contextual factors on innovation outcomes through firm attributes in the manufacturing sector?

In the manufacturing sector, the firm attributes 'capability' and their 'transformational actions' are the apparent dimensions of NIS that intersected the relationship between contextual dimensions and the innovation outcomes. The contextual dimensions that are obvious in the research context are 'market knowledge factor', 'government support infrastructure and institution', 'infrastructure and institution for private sources' and 'funding infrastructure'. Three important interpretations can be made from the relationships obtained for the manufacturing sector.

Firstly, the effect of the contextual dimension of NIS 'market knowledge factor' on 'innovation outcome' is suppressed through the intersection of firm attributes. Firm attributes firms' 'capability' and 'transformative actions' act as suppressing agents here. 'Market knowledge factor' here reflects the unavailability of the information needed at the right time for innovation. When the information needed for innovation is not available at the right time in the national context, the effect of firm attributes on innovation outcomes is aggravated in a negative sense. 'Market knowledge factor' refers to imperfect knowledge in the market, which leads to knowledge asymmetry. Knowledge asymmetry could lead to a market opportunity that enables innovation or market failure increasing transaction costs. The second role of market knowledge factor very much depends on the firms' capabilities or characteristics. Market knowledge factor influences firms' capabilities, which in turn leads to innovation outcomes. As per the findings above, in the research context of Malaysia, the influence of 'knowledge market factor' on innovation outcomes through firms is negative. The finding indicates that firms are not able to recognise the opportunities in knowledge asymmetry and exploit them to develop new ideas. They may be focusing on lowering the transaction costs. The situation is explained by Barbaroux (2014) as building capabilities out of asymmetries depends on the firms' ability. The author also indicated that firms require both internally and externally oriented processes to perform this. In the context of information asymmetry, firms are expected to "build their competitive advantage, not on resources and capabilities as the resource-based view (RBV) suggests. However, on asymmetries in skills, processes and a variety of tangible and intangible assets (including cultural values), which their competitors cannot copy and absorb at a cost that affords economic rents" (Barbaroux, 2014, p.11).

Secondly, the results from the manufacturing sector also demonstrate that firm attributes partly mediate the relationships between 'government support infrastructure and institution' and 'innovation outcomes' (38%); 'infrastructure and institution for private source' and 'innovation outcomes' (65%); and 'funding infrastructure' and 'innovation outcomes' (75%). While the contextual dimensions 'government support infrastructure and institution' and 'infrastructure and institution for private sources' influence 'innovation outcomes' positively through firm attributes, 'funding infrastructure' influences it negatively. Based on the indicators, the infrastructure and institution referred here are associated with knowledge, technology and incentives. While the infrastructure and institutions related to knowledge and financial incentives influence innovation outcomes positively to some extent, the funding options available for firms in the manufacturing sector from the public and other sources are limiting the firms' innovation activities and thus the overall innovation outcomes.

Thirdly, the model proposed for manufacturing sector relating national contextual dimensions of NIS to innovation outcomes through firms was able to explain and predict firm-level innovation outcomes. All the intervening and endogenous variables (firms' capability, their transformational actions and the innovation outcomes) had predictive relevance in the manufacturing sector.

6.5.2.2. Research Issue 3.2
What are the effects of contextual factors on innovation outcomes through firm attributes in services sector?

In the services sector, the firm attributes segregate into 'resource capability', 'financial capability', 'cooperation' and 'transformational actions' and form apparent dimensions of NIS that intersected the relationship between contextual dimensions and the innovation outcomes. The contextual dimensions that are obvious in the research context of services sector are 'market knowledge factor', 'government support infrastructure and institution', 'knowledge infrastructure and institution' and 'funding infrastructure'. Four important interpretations can be made from the relationships obtained for the services sector.

Firstly, the results from the services sector demonstrated that the firm attributes partly mediate the relationship between 'government support infrastructure and institution' and 'innovation outcomes' (69%). 'Government support infrastructure and institution' refers here the technical support and incentives to firms and it positively influences the innovation outcomes through the firms.

Secondly, the indirect effect of 'funding infrastructure' (includes both private and public funding) on innovation outcomes through firm attributes is not evident. However, this dimension cannot be entirely neglected because as funding is essential for innovation activities.

Thirdly, it is also noted from the results that firm attributes act as suppressors in the relationship between 'knowledge infrastructure' and 'innovation outcomes'; and 'market knowledge factor' and 'innovation outcomes'. The findings indicate that higher the challenge to source for knowledge for innovation from different stakeholders (knowledge infrastructure) and lack of information at the right time from the markets and IPPs (market knowledge factor) discourage firms for innovation-related activities, and they produce fewer innovation outcomes. Though these two effects are not statistically evident, they provide useful insights and worth considering.

Fourthly, despite having issues in establishing evidence for the relationships, the model proposed for services sector relating national contextual dimensions of NIS to innovation outcomes through firms shows the ability to explain and predict firm-level innovation outcomes. All the intervening and endogenous variables (firms' resource capability, their transformative actions, cooperation and innovation outcomes) had predictive relevance except for the dimension firms' financial capability.

6.5.2.3. Research Issue 3.3

How do the effects of contextual factors on innovation outcomes through firm attributes differ between manufacturing and services sectors?

The differences between the manufacturing and services sector can be established in four aspects.

Firstly, national contextual dimensions of NIS influence firms in the manufacturing sector, which is evident from the findings. However, in the services sector, it is not evident except for 'government support infrastructure and institution'. It indicates that firms in services sector work within themselves.

Secondly, in both the sectors, partial mediations and suppressions noted. In the manufacturing sector, firm attributes partially mediate three relationships between contextual dimensions of NIS and innovation outcomes ('government support infrastructure and institution' to innovation outcomes; 'funding infrastructure' to innovation outcomes; and 'infrastructure and institution for private sources'). However, there is only one noted in the services sector, which is 'government support infrastructure and institution', which is statically evident. Both the sectors showed suppression effects, mostly related to knowledge unavailability. While manufacturing sector suffered from getting the right information at the right time, services sector suffered from getting information from different stakeholders as well as getting information at the right time.

Thirdly, both the models proposed for both the sectors had substantial explanatory power indicating the predictive accuracy of the model for planning purposes. However, the model from manufacturing sector had higher explanatory power and thus higher predictive accuracy.

Fourthly, considering the intervening and endogenous variables, all (firms' capability, their transformational actions and the innovation outcomes) of them had predictive relevance in the manufacturing sector. However, in the services sector, all (firms' resource capability, their transformative actions, cooperation and innovation outcomes) of intervening and endogenous variables had predictive relevance except for firms' financial capability'.

6.6. Summary

This chapter empirically examines the indirect influence of dimensions of NIS regarding national contexts on innovation outcomes through firm attributes, which can be comprehensively governed at the national level to enhance innovation outcomes. The results show evidence of indirect effect regarding partial mediation and suppression (inconsistent mediation) in the manufacturing sector and one partial mediation in the services sector.

In general, in the manufacturing sector, the firm attributes 'capability' and their 'transformational actions' are the apparent dimensions of NIS that intersected the relationship between contextual dimensions and the innovation outcomes. The interpretations made by evaluating the indirect effect of national contextual factors on innovation outcomes are, firstly, when the information needed for innovation is not available at the right time in the national context, the effect of firm attributes on innovation outcomes is aggravated in a negative sense. Secondly, infrastructure and institutions related to knowledge, financial incentives influence innovation outcomes positively to some extent and thirdly, the funding options available for firms from manufacturing sector from the public, and other sources are limiting the firms' innovation activities and thus the overall innovation outcomes.

In the services sector, the firm attributes 'resource capability', 'financial capability', 'cooperation' and 'transformational actions' are the apparent dimensions of NIS that intersected the relationship between contextual dimensions and the innovation outcomes. 'Government support infrastructure and institution' (related to technical support and incentives to firms) positively influences the innovation outcomes through the firms, and the indirect effects of 'funding infrastructure', 'knowledge infrastructure' and 'market knowledge factor' on 'innovation outcomes' are not evident. While the effect of 'funding infrastructure' showed insignificant partial mediation, the others showed insignificant suppression effects. Though these three relationships are not statistically evident, they provide useful insights and worth considering.

When both the sectors are compared, the firms in the manufacturing sector are influenced by national contextual dimensions of NIS, but not in services sector except for 'government support infrastructure and institution'. In both the sectors, partial mediations and suppressions noted. In the manufacturing sector, firm attributes partially mediate three relationships between contextual dimensions of NIS and innovation outcomes ('government support infrastructure and institution' to innovation outcomes; 'funding infrastructure' to innovation outcomes; and 'infrastructure and institution for private sources'). However, there is only one noted in the services sector, which is 'government support infrastructure and institution', which is statically evident. Both the sectors showed suppression effects, mostly related to knowledge unavailability. While manufacturing sector suffered from getting the right information at the right time, services sector suffered from getting information from different stakeholders as well as getting information at the right time. However, the models proposed for both the sectors had substantial explanatory power indicating the predictive accuracy of the model for planning purposes. However, the model from manufacturing sector had higher explanatory power and thus higher predictive accuracy. Further, all the intervening and endogenous variables from both sectors had predictive relevance except for firms' financial capability' in the services sector. The findings of the study provide evidence of complex interactions between a firm and its environment. Smith (2000) and Lundvall (2005) highlighted that these evidence of complex interactions help to comprehend the broader factors shaping the behaviour of firms. Therefore, this is a significant contribution.

CHAPTER 7: CONCLUSION

7.1. Introduction

This study aims to take advantage of information structures of national environment and firms of an emerging economy to explain the embedded NIS and resultant innovation outcomes. This study is an attempt to contribute to the explanatory power of NIS in assessing and influencing the performance of national innovation outcomes for policy purposes. This chapter summarises the study, synthesises findings and discusses theoretical and policy contributions of findings. Demand-oriented system promotion aspect of NIS for emerging economies is drawn from three approaches namely: system approaches to innovation (Edquist & Hommen, 1999; Lundvall, 2007; Smith, 2000), interactive learning theories (Lundvall, 1992; Nielsen, 1991) and development block approach (Dahmen, 1988; Edquist & Lundvall, 1993; Freeman, 1991). These approaches enable to unravel two main constituents (national contexts and firm attributes) and six macro dimensions of NIS within these constituents namely infrastructure, institution, market factors, firm capability, interactions and transformational factors. These dimensions are prominent with 21 sub-dimensions (micro level) as per the literature discussed in chapter 2. Therefore, these major and sub-dimensions are meant to provide explanations of NIS at both macro (surface) as well as micro (deep) levels using empirical data of firms' activities.

The study conducted a comprehensive literature review and an examination of scholarly discussions of NIS. Based on the literature, this study considers national contextual measures as the antecedents of firm attributes, whereas firms' capability, their interactions and transformative attributes and innovation outcomes as consequences of national contexts. This study considers firm attributes (capability, cooperation and transformative characteristics) as overall stimulus developed through national infrastructure, institutional provisions and market conditions. These ideals translate into the conceptualisation of the research model that presents dimensions of NIS and their interrelationships in influencing innovation outcomes.

This study looks for truth or knowledge based on verified hypotheses, and positivist research paradigm guides the study. Within the positivism paradigm, the philosophy that guides the study is objectivism, and the research design that employs quantitative methods is used. The study uses the analytical survey to unravel variables and test theory through the exploration of the relationship between variables. Data from Malaysian National Innovation Survey 2012 is used for the study. The data is analysed to address the three research issues raised in the chapter (a) A hybrid factor analytic model is used to unravel and validate first- and second-order dimensions of NIS. A PLS-SEM path modelling analysis is used to test and validate structural models for (b) the direct effect of contextual factors and firm attributes on innovation outcomes (to study systemic enablers or problems) and (c) indirect effect of national contextual factors on innovation outcomes through firms' attributes.

Following the summary in the introduction, the section below covers synthesis of empirical findings. Theoretical and policy contributions follow the synthesis. The chapter ends with a discussion on future possible research directions in this area of study.

7.2. Synthesis of Findings

This section synthesises the results of the three research issues investigated. The findings of the first research issue that investigated prevalent dimensions of NIS establish valid and sound hierarchical (two-level) factor structure of national contexts and firm attributes explaining NIS for both manufacturing and services sectors. The results also indicate that dimensions of NIS explaining national innovation outcomes of emerging economies differ in their patterns from the conceptual discussions of NIS, which are based on developed economies. The patterns of NIS emerged from the empirical investigation also differ between manufacturing and services sectors. Comparison with similar studies (e.g. Chaminade et al., 2012; Leiponen & Drejer, 2007; Srholec & Verspagen, 2008) provided some insights on similarities with developed economies, the distinctiveness of emerging economies and the research context, which is Malaysia.

NIS that exists in the manufacturing sector of an emerging economy is composed of six dimensions at the macro (surface) level as carriers of innovation outcomes and sixteen dimensions at the micro (deep) level as perceived ideas or rules explaining innovation outcomes. Data from the manufacturing sector show traces of all macro dimensions and more than half of the micro dimensions of NIS proposed based on literature. At the macro level of the manufacturing sector, 'knowledge infrastructure', 'cooperation' and 'transformative actions' dimensions are similar to the developed economies. The findings indicate that the carrier to realise innovation outcomes in the manufacturing sector is 'knowledge infrastructure', which represents universities, research labs and training systems to access to knowledge, expertise, know-how and strategic information, being part of formal (e.g. university-industry linkages) and informal networks to engage in innovation, and ability to adapt to new technological developments. The findings from manufacturing sector are also in alignment with studies above in showing patterns of overlap in 'infrastructure' and 'institutions'. Further, knowledge related infrastructure and institutions are apparent in the studies mentioned above, which indicates that firms perceive knowledge related support from national context quite prominently as a carrier of innovation outcomes despite the level of development. The pattern of 'government support infrastructure and institution' is distinctive to the manufacturing sector of emerging economies and mainly skewed to financial incentives and technical support. This pattern indicates that firms in emerging economies perceive a need for government support to realise innovation. The findings also indicate that firms perceive different patterns between public and private sectors in dealing with innovation and prominent role of knowledge market for innovation outcomes.

At the micro level of the manufacturing sector, firms' perceive knowledge related infrastructure (universities, research labs, training systems), Intellectual Property Protection, formal and informal networks and shared vision and direction for the future as rules for innovation outcomes irrespective of the development status of the nations. However, the findings also indicate infrastructure regarding technical support and funding and ability to articulate demand as essential rules to guide innovation at the deep level in emerging economies. Firms also perceive the role of knowledge markets, ability to access stocks of knowledge, competency and resources internally and externally, and multi-level coordination to make interventions at the right time as micro level principles to explain innovation in Malaysia.

NIS that exists in the services sector of an emerging economy is composed of eight dimensions at the macro (surface) level as carriers of innovation outcomes and seventeen dimensions at the micro (deep) level as perceived ideas or rules that explain innovation outcomes. Data from services sector show traces of all macro dimensions and nearly half of the micro dimensions of NIS proposed based on literature. At macro level of the services sector, 'knowledge infrastructure', 'cooperation' and 'transformative actions' dimensions are similar to developed economies. These macro dimensions are carriers to explain innovation outcomes in the services sector. While patterns of 'knowledge infrastructure' exists in both developed and emerging economies, patterns of 'funding infrastructure' and 'government support' are unique to emerging economies. Firms from services sector perceive that allocation of funds by governments and other support regarding institutions and technology consultancy are important as carriers of innovation in emerging economies. Further, infrastructure segregated into funding and knowledge and 'market knowledge factors' are unique to the research context. Firms from services sector also perceive that provision of distinctive knowledge and funding related infrastructure and timely access to market knowledge are carriers of innovation outcomes in Malaysia.

At the micro level of the services sector, knowledge infrastructure, intellectual property protection, collaboration with universities, research labs and other informal networks, and shared vision and standards to guide and consolidate direction of change are deep level rules to guide innovation irrespective of the level of development. The findings also indicate that firms from services sector perceive provision of technical information, technologies, research and test facilities and reliable data, allocation of funds for research and innovation, regulations governing funding and ability to articulate demand as principles governing innovation outcomes at the deep level in emerging economies. Further firms' ability to access to market information and necessary resources (e.g.

expertise, competencies) on time internally and externally guide innovations at the deep level in Malaysia.

The findings also show differences between sectors regarding the composition of some macro and micro dimensions in explaining innovation outcomes. At the macro level, both sectors perceive government support regarding infrastructure and institution related to technological and financial aspects, availability of market knowledge on time and ability to adapt to new technological developments as carriers of innovation outcomes. Firms' perception of 'institution', 'infrastructure', 'capability' and 'cooperation' dimensions slightly differ between manufacturing and services sectors. The institution and infrastructure emerge together for public and private segments in the manufacturing sector. In the services sector, infrastructure dimension segregates into knowledge and funding. Capability and cooperation subsume into one in manufacturing while they show individual patterns in the services sector. In the services sector, the capability dimension further segregates into a resource and financial capability. Firms from both the sectors perceive similar principles to guide innovation at the micro-level except for 'knowledge infrastructure' and 'cooperation' aspects. There are more segregations seen in these dimensions in the services sector. 'Knowledge infrastructure' dimension segregates into industry knowledge, business knowledge and scientific knowledge. 'Cooperation' dimension segregates into inter-firm and scientific knowledge cooperation.

The findings of the first research issue establish differences in perceptions of firms between emerging and developed economies and between manufacturing and services sectors. The findings of the study also make it evident that previous studies did not attempt to differentiate between context related and film-related factors.

The second research issue investigated systemic enablers and problems by examining the direct effect of dimensions of NIS (at two-levels) on innovation outcomes. At macro level of the manufacturing sector, only 'market knowledge factor' emerges as a systemic problem. The market in terms of 'information asymmetries' act as a barrier to innovation outcomes, which indicates that firms do not realise the market opportunity. At the micro level, firms find it difficult articulating demand for innovation and allocating funds or getting funding for innovation-related projects in the manufacturing sector.

The findings also indicate evidence of one systemic enabler (resource capability) and no systemic problems in the NIS of service sector at the macro view of the research context. This finding indicates that only people, technology and other forms of resources of firms in services sector enable innovation as perceived by firms. Further, firms from services sector do not perceive any challenges in achieving innovation outcomes in the micro-level. The findings also indicate that firms in services sector believe that their capability regarding their resources and their ability to make use of external resources enable innovation outcomes. There are only a few significant relationships in services sector compared to the manufacturing sector. Manufacturing sector shows evidence of systemic enablers and problems related to both firms as well as national contextual aspects. Services sector shows evidence of only a few enablers and are related to firms' capability. There may be different possible reasons that can be attributed to this. In general, the analysis picked up more enablers than barriers in both the sectors, which seems to be promising. However, it is possible for the few problems to overpower all the enablers firms perceive, which require further investigation.

The third research problem investigated the indirect effect of national contextual dimensions of NIS on innovation outcomes through firm attributes. It concluded that firm attributes (capability and transformative actions) intersect the relationship between national contextual factors (infrastructure and institution for private sources, Government support infrastructure and institution, public and other funding infrastructure and market knowledge factor) and innovation outcomes in the manufacturing sector. Firm attributes partly (partial mediation) explain the relationships between 'infrastructure and institution for private sources', 'government support infrastructure and institution', 'funding infrastructure' and innovation outcomes. While infrastructure and institutions related to public and private segments influence innovation outcomes positively, funding options available are limiting innovation activities of firms from the manufacturing sector and thus influencing the overall innovation outcomes negatively. Firm attributes suppress the effect of market knowledge factor on innovation outcomes negatively, which indicates that firms are not able to capitalise the opportunities available in the market in the form of information asymmetry for innovation outcomes. Knowledge asymmetry has lowered the innovation outcomes to a large extent, which is not favourable to the economy.

The investigation for the services sector concluded that firm attributes (resource capability, financial capability, cooperation and transformative actions) partially explain the relationship between only one national contextual factor 'Government support infrastructure and institution' and innovation outcomes. Technology support and incentives to firms by governments positively influence innovation outcomes through firms. The other contextual dimensions of NIS in services sector such as knowledge infrastructure, funding infrastructure, and market knowledge factor do not establish the significant indirect effect on innovation outcomes. Further, the effect of 'funding infrastructure' shows insignificant partial mediation and the others show insignificant suppression effects.

When sectors are compared, national contextual dimensions of NIS influence innovation outcomes through firms in the manufacturing sector, which is evident from the findings. However, in the services sector, it is not evident except for 'government support infrastructure and institution'. It indicates that firms in services sector work within themselves. In both sectors, partial mediations and suppressions noted. In the manufacturing sector, firm attributes partially explain relationships between contextual dimensions of NIS ('government support infrastructure and institution', 'funding infrastructure' and 'infrastructure and institution for private sources') and innovation outcomes. However, there is only one statistically evident relationship noted in the services sector, which is between 'government support infrastructure and institution' and innovation outcomes through firms' attributes. Both the sectors showed suppression effects, mostly related to knowledge unavailability. Firms from both the sectors have problem capitalising on knowledge asymmetry in the market for innovation outcomes. The services sector suffers further from getting information from different stakeholders as well as getting information at the right time. Models proposed for both the sectors have substantial explanatory power indicating the predictive accuracy of the models for planning purposes. However, the model from manufacturing sector had higher explanatory power and thus higher predictive accuracy.

In general, the findings for the three research issues investigated unravel valid and sound two-level dimensions of NIS and establish a direct and indirect relationship of national contexts on innovation outcomes with good explanatory power and predictive relevance.

The findings also show differences from the proposed ideas, which are concepts based on developed economies. Further, they are also different between manufacturing and services sectors in certain aspects. This study has significant theoretical and policy contributions, which are discussed in the following section.

7.3. Contributions of the Study

Developing comprehensive measures of National Innovation System (NIS) to realise innovation outcomes for national benefit is a challenge. Therefore, it is common in scholarly discussions to use stakeholders' opinion when it is difficult to gather actual measures (Carroll, 2000). This study has explored dimensions of NIS in an emerging economy from information structures of activities of firms from firms' perspectives. An elaborate scale development process (factor analytic model) on the data from Malaysian National Innovation Survey provided factor structures of NIS for both manufacturing and services sectors that have some important implications. These factor structures are used to evaluate systemic enablers and problems as well as interrelationships. The findings of the study have important theoretical and policy contributions.

7.3.1. Theoretical Contributions

In general, this research contributes to theory by explaining dimensions of National Innovation System, their direct and indirect association with innovation outcomes within an emerging or developing economy context. Further, as Edquist (2005) pointed out, this study employed theory-based empirical research to straighten up the NIS approach and made it more theory-like. The theoretical contributions are discussed below.

First, this study contributes by providing a better understanding of NIS. It extends current understanding of NIS literature by examining Innovation System (IS) literature (guided by innovation, learning and evolutionary theories) as a perspective of economic analysis and building block in conceptualising NIS. From the analysis of literature, this study concludes that NIS is a macroeconomic explanation for economic growth through the understanding of micro-aspects. It also concludes that NIS can provide better explanations of national innovation outcomes if it is conceptualised as a multi-dimensional and multi-level construct and studied regarding two major constituents, national environments and firms. The conclusion from the literature review also includes that dimensions of NIS can be modelled to use as an underlying theoretical lens to examine systemic enablers and problems and explain innovation outcomes through interrelationships and indirect effects.

Second, this study attempts to extend knowledge by integrating demand-oriented theories or approaches namely; the system approaches to innovation, interactive learning theories and development block approach for demand-oriented NIS for system promotion in emerging economy context. From explanations of these approaches, dimensions constituting NIS are derived. These three theories or approaches guide the study to understand NIS in its two main constituents, national contexts and firm attributes. Also, they also enable a comprehensive understanding of NIS (as a whole) regarding three contextual dimensions (infrastructure, institution and market factors) and three firm-related dimensions (capability, cooperation and transformational attributes) at macro-level to influence innovation outcomes for economic benefit. It helps to overcome deficiencies of previous studies that approached NIS from supply orientation rather than demand (system development) and usually dealt with specific elements or dimensions of NIS.

Third, this study also contributes to strengthening the concept of NIS by exploring and explaining NIS as a two-level concept empirically. By conceptualising NIS as a two-level concept, NIS can provide ‘deep’ (micro) level of ideas or generic rules, and of a ‘surface’ (macro) level composed of their actualisations in carriers as indicated by Bleda and Del Río (2013) and Dopfer and Potts (2009). The findings of the study unravelled sound and valid two-level dimensions of the NIS for both manufacturing and services sectors, which could provide a comprehensive understanding of NIS in manufacturing and services sectors of emerging economies for scholars.

This study attempts to extend the NIS approach by proposing the use of ‘national context’ and ‘firm attributes’ as main constituents to explain dimensions of NIS for system promotion in emerging economies. This explanation is necessary based on discussions of Lundvall (1992), Nelson (1993), Edquist (1997), Lundvall (2005), OECD and Eurostat (2005), Niosi (2011) and Klochikhin (2012) on the differences in national contexts between developed and emerging economies. Based on the discussions of Lundvall (2005), Whitley (2007) and Patana, Pihlajamaa, Polvinen, Carleton, & Kanto (2013) and Scandura (2015), innovation and economic benefit are based on firms’ activities. It is necessary to consider ‘firm attributes’ because firms behave differently in emerging economies, they are the core of the NIS, and an explanation of NIS from firms is critical (Lundvall, 2007). Further, this study extended the body of knowledge by differentiating the sectoral differences between manufacturing and services sectors. This understanding of the sectoral differences is also necessary based on the discussions of Pavitt (1984), Dosi et al., (1995), Malerba and Orsenigo (1997), Malerba (2002), and Arundel, Lorenz, Lundvall, and Valeyre (2007) on the sectoral differences and innovation outcomes. The findings of the study unravel sound and valid two-level dimensions of NIS within the two main constituents, ‘national contexts’ and ‘firms’ attributes’. The study concludes with four dimensions in the national context of NIS with prominent institutions and infrastructure (skewed to government support), market knowledge factor and segregated infrastructure. These dimensions showed differences from proposed dimensions based on developed economies and previous studies. The study further concludes with firm attributes that are prominent in 'transformational attributes', 'capability' aspects, but capability and cooperation aspects differed. The findings also show differences between the sectors regarding infrastructure (segregate into public and private related in the manufacturing sector and knowledge and funding related in services sector) and capability (combined with cooperation in manufacturing, but shows separate patterns in services sector). These differences in the national contexts, firm attributes and sectors are important contributions to theory.

Fourth, this study contributes to identifying systemic enablers and problems of NIS in Malaysian context by examining direct influence of micro and macro dimensions of NIS on innovation outcomes. It further adds on to the understanding by establishing differences between manufacturing and services sectors. This understanding of systemic problems and enablers is necessary because the success of innovations is to a large extent determined by how the innovation system is build up (Bergek et al., 2008; Hekkert et al., 2007). An understanding of what enables and blocks innovation outcomes is crucial as it can give better knowledge of how to manipulate national policies towards economic benefit through innovation outcomes. The findings conclude that firms from manufacturing sector perceive that they are able in their level and supported by their national context regarding infrastructure and institution from both public and private entities. Firms from manufacturing sector view infrastructure and institution as a support aspect without clearly distinguishing them. However, they are challenged in articulating demand and getting funds for innovation at the micro-level and lack of market details at the macro-level. In the services sector, the firms do not perceive any challenges in achieving innovation outcomes in micro-level. This finding can be attributed to the nature of the sector consisting of a higher percentage of small firms for which innovation may not be the priority and hence the challenges are not realised.

Finally, this study supports nomological validation of the proposed NIS model in the context of an emerging economy with an intention to strengthen or develop demand-oriented NIS. As proposed, national contextual dimensions indirectly influence innovation outcomes through firm attributes. Firms play a critical role in influencing innovation outcomes within national contexts. There are suggestions in scholarly discussions that it is critical to know the microstructures. Otherwise, scholars and policymakers might get little out of attempts to manipulate institutions and organisations at meso- and macro-level (Lundvall, 2007). The findings of this study provide additional support to the robustness of the proposed model in explaining almost all relational exchanges in the manufacturing sector, but for some in the services sector in an emerging economy context. The results of this study extend current understanding of the role of national contexts and firms' attributes when examining the performance of NIS for innovation outcomes. Previous studies often dealt with specific dimensions and not with direct and indirect relationships.

From the theoretical viewpoint, this study contributes to explaining NIS in an emerging context in two-levels (as micro level ideas and macro level movers of innovation), assessing the systemic enablers and problems in two-levels (micro and macro), and providing a framework to examine determinants of innovation outcomes in an emerging economy. The study also extends understanding by demonstrating the indirect effect of national contextual dimensions on innovation outcomes through firm attributes and sectoral differences between manufacturing and services sectors. As discussed, the theoretical contributions of this study are many folds. The following section discusses policy contributions.

7.3.2. Policy Contributions

The findings of this study provide important implications for Governments or nations in devising a policy for innovation. Policy makers will be interested in the findings of this study as it gives a better understanding of NIS on two levels. With this knowledge, policymakers can understand the analytical approach NIS in two-levels in explaining national innovation outcomes, systemic enablers and problems by assessing direct influence of dimensions of NIS on innovation outcomes, and interrelationships by assessing the indirect effect of national contextual attributes on innovation outcomes through firm attributes. The policy contributions are discussed below.

First of all, the results indicate that dimensions of NIS explaining national innovation outcomes of emerging economies differ in their patterns from conceptual discussions of NIS that are based on developed economies. In general, the findings confirm that there are valid and sound two-level dimensions of national contexts and firm attributes explaining NIS, which differ between manufacturing and services sectors and different in certain aspects of developed economies. The two-level dimensions provide both micro (or deep) level ideas or rules of the game and macro (or surface) level carriers of innovation realisation, provide an understanding of NIS regarding national contexts and firm attributes and establish differences between manufacturing and services sector. Having a comprehensive understanding of the NIS in its multi-dimensionality and multi-level is important for policy owners to evaluate strengths and weaknesses and existence or absence of specific dimensions to develop fully functional NIS. It also enables to adopt policies accordingly for the emerging economy context.

Secondly, the findings of the study provide evidence that the firms are challenged regarding articulating demand for innovation and allocating funds or getting funding for innovation-related projects at micro (deep) level in the manufacturing sector. At the macro (surface) level, they are challenged with market details required for their innovation-decision. However, in the services sector, the findings do not show any evidence of challenge, which can be explained as most of the firms from services sector in this sample are from small to medium-sized firms. Therefore, policy devisors should look into issues in the NIS of Malaysia. The sectors should be dealt separately, and services sector needs to be reworked in the area of innovation, as it is one of the major contributors of GDP. By having, a good understanding of what enables and blocks innovation outcomes is important as it can give better knowledge of how to manipulate national policies towards economic benefit through innovation outcomes.

Thirdly, the findings of this study provide evidence for manufacturing sector that firm attributes (capability and transformative actions) intersect relationships between national contextual factors (infrastructure and institution for private sources, Government support infrastructure and institution, public and other funding infrastructure and market knowledge factor) and innovation outcomes. While the firm attributes partially mediate relationships of 'infrastructure and institution for private sources', 'Government support infrastructure and institution', 'public and other funding infrastructure' with innovation outcomes, they suppress the effect of 'market knowledge factor' with innovation outcomes. 'Market knowledge factor' and 'funding infrastructure' influence innovation outcomes negatively. Policy developers can influence innovation outcomes in the manufacturing sector by facilitating information needed for innovation to be available at the right time in the national context, enhancing infrastructure and institutions related to knowledge and financial incentives and creating different avenues for funding for firms.

Fourthly, the findings of this study provide evidence for services sector that firm attributes (resource capability, financial capability, cooperation and transformative actions) intersect the relationship between only one national contextual factor 'Government support infrastructure and institution' and innovation outcomes. Therefore, policy owners should consider enhancing government support regarding technical support and financial incentives as it shows a positive effect on innovation outcomes. The rest of the contextual dimensions of NIS in services sector such as knowledge infrastructure, funding infrastructure, and market knowledge factor do not establish the significant indirect effect on innovation outcomes. Though these three relationships are not statistically evident, they provide useful insights and worth considering. While the effect of 'funding infrastructure' shows insignificant partial mediation, the others show insignificant suppression effects. Policy owners should consider these aspects as funding is very critical and lack of knowledge infrastructure and market-related information might adversely affect innovation outcomes. With a composition of many small and medium-sized establishments, services sectors priority is not towards innovation. Policy owners and Governments have to play a role in evaluating and manipulating the national contextual dimension through suitable policies to influence firms' activities towards innovation outcomes for national benefit in emerging economies.

From the policy viewpoint, this study provides important guidance to nations and their policy owners or devisors. In general, the findings of this study can be of help to policy owners to have a comprehensive understanding of the NIS in its multi-dimensionality and multi-level to evaluate strengths and weaknesses and existence or absence of the dimensions to work towards a complete or fully functional NIS or to adopt policies accordingly for the emerging economy context. The findings also build the understanding of what enables and blocks the innovation as it can give better knowledge on how to manipulate the national policies towards economic benefit through innovation outcomes; and have an understanding of the interrelationships. This understanding would enable policy owners and Governments to play a role in evaluating and manipulating national contextual dimension through suitable policies and to influence firms' activities in different sectors towards innovation outcomes (for national benefit) in emerging economies.

From a practical viewpoint, firms in emerging economies may use the insights from this study to enhance their attributes and strategise their ability to exploit national contexts and negotiate with governments for innovation and economic benefits. Firms in both sectors need to work on their cooperation aspects and their transformational characteristics. It is vital for firms to engage in formal and informal networks to get access to current and new knowledge, which is critical to realise innovation. Firms also need to adapt to technological developments with a futuristic vision to engage in innovation and realise economic benefits. Considering services sector, financial capability of the firms seem to be a challenge to engage in innovation, which is mainly due to the size (small to medium) of firms in the services sector. Firms in services sector need to work with government and exploit technical and financial support provided by them. The following future research options look promising to add insights to the NIS concept.

7.4. Future Research Suggestions

This section discusses some directions for future research. First of all, NIS is a multi-dimensional concept. This study has considered the concept comprehensively mostly taking into account of economic and organisation related dimensions. However, based on Johnson et al. (2003), NIS has a trait for social, political and historical dimensions. The inclusion of these dimensions and their relationships with innovation outcomes will add further insight to the understanding of the concept NIS. Therefore, future research should include these dimensions.

Secondly, this study uses cross-sectional data from Malaysian National Innovation Survey 2012 to unravel dimensions of NIS and explore their inter-relationships. NIS has a path dependence characteristic. Past choices invariably impose restraints and contribute to innovation (Dosi, 1988; Nelson & Winter, 1982; OECD, 2007). The constituents of NIS (both national contexts and firm attributes) and their direct and indirect effect on innovation outcomes may change over time depending on lessons learnt and the past. Thus, future research should consider this change over time by employing a longitudinal study setting to check if dimensions of NIS and their relationships are consistent over time, or to monitor the impact of changes on innovation outcomes.

Thirdly, this study focuses the research problem from firms' perspective. However, policy owners' perspective on the NIS of emerging economies would be interesting to investigate. Potential gaps or incongruence in the understanding of NIS between policy devisors and firms will be useful for policy devisors looking to understand and enhance NIS for economic development or catching-up. Therefore, future studies may consider this.

Fourthly, the findings may be relevant to Asian emerging countries due to the nature of the literature and empirical evidence used. The study can be extended further to other regions. Finally, this study attempts to operationalise the NIS concept for an emerging economy using large samples from which some generalisations can be made. This study answered the question, what is out there in the NIS of an emerging economy? However, using multiple methods to establish different views of the concept NIS using small samples researched in depth or over time is also interesting. This study focused mainly on organisational and economic related dimension, and it would be interesting to study social, cultural, and mental phenomena focusing on meaning to reveal why NIS behaves in certain ways to realise innovation outcomes. Future research may consider this.

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LIST OF PUBLICATIONS

1. Journal Article (SSCI & Scopus indexed)

Subramonian, H. & Rasiah, R. (2016). University-industry collaboration and technological innovation: sequential mediation of knowledge transfer and barriers in automotive and biotechnology firms in Malaysia. *Asian Journal of Technology Innovation.* DOI: http://dx.doi.org/10.1080/19761597.2016.1151177 *[SSCI & Scopus Indexed].*

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University–industry collaboration and technological innovation: sequential mediation of knowledge transfer and barriers in automotive and biotechnology firms in Malaysia

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Technological Innovation (TI) is a critical outcome of innovation systems. Previous studies have investigated the drivers of university–industry (U–I) collaborations without looking at relationships and their influencing factors. This paper fills this gap by examining U–I links in the automotive and biotechnology sectors in Malaysia. The exercise produced three key results. Firstly, there was a significant but negative association between perceived importance of universities and firm-level TI, which indicates that firms have used universities in Malaysia less than their perceived importance. Secondly, the results demonstrate that the sequential effect of knowledge transfer (KT) channels and perceived barriers fully mediate the relationship between universities and TI. Firms that regard universities as important to TI also placed emphasis on KT channels and barriers. While professional recognition and advancement depend on being first to disclose and publish research results, industrial innovation relies heavily on secrecy. Thirdly, the perceived importance of universities when viewed together with KT channels and perceived barriers, explains and predicts firm-level TI, which was significantly different in the two sectors. Furthermore, automotive firms reported higher perceived importance of universities than biotechnology firms in research, teaching, and entrepreneurship.

Keywords: University–industry collaboration, universities, knowledge transfer mechanism, barrier, technological innovation

1. Introduction

One of the outcomes of University–Industry (U–I) linkages or university entrepreneurship targeted at economic impact is Technological Innovation (TI). TI supports the development of new products and processes. Eom and Lee (2010), Teixeira and Mota (2012), Freitas, Geuna, and Rossi (2013) and Ankrah, Burgess, Grimshaw, and Shaw (2013) had indicated that U–I collaboration is a critical component of innovation systems (ISs). According to Herrera, Muñoz-Doyague, and Nieto (2010, p. 510), scientific knowledge produced by public researchers offers new opportunities to promote firms' innovation efforts, which in combination with knowledge that the firm already has, creates new opportunities for new product development (see also Ahuja, Lampert, and Tandon 2008; Cohen, Nelson, and Walsh 2002; Yli-Renko, Autio and Sapienza 2001). However, if universities and firms are not aware of the status and benefits they could appropriate through linkages, they might not engage in such valuable collaborations.

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2. Book Chapter

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